Engineering Management
Field Project

Identifying External Risks in Saudi Power Generation Projects

By

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in partial fulfillment of the requirements for the degree of
Master's of Science

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TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF TABLES

Page

PLEASE NOTE

It is noted by the Committee Chair that this document will be used by various industry groups in Saudi Arabia and serves simultaneously as an academic report for KU Engineering Management. It is the tradition of the Engineering Management department to accommodate the author's need to prepare one document useable by all constituencies. Further, this document was written and edited with different software in different parts of our world. It must be understood that the format of citation, spelling, grammar, syntax and the like are slightly altered to facilitate the ease of understanding by the eventual users.

Herbert Tuttle, Committee Chair

DEDICATION AND ACKNOLEDGMENTS

I dedicate this research to my parents
and family, who encouraged me and
supported my graduate program.

Acknowledgement is due to the University of Kansas for support of this research. I wish to express my appreciation to Mr. Herbert Tuttle who served as my major advisor. I also wish to thank the other members of my Field Project Committee, Dr. Tom Bowlin and Mr. Brian McCarthy for their comments and suggestions.

EXECUTIVE SUMMARY

The Saudi Power Generation Project market is fast growing with more international EPC contractors and consultants entering this market. Understanding the risks, whether threats or opportunities, involved in the engineering, procurement, and construction of a Saudi power generation project will ensure the success of new power generation projects in Saudi Arabia.

The six Risk Management Process steps, adopted by the Project Management Institute (PMI), were explained, with more emphases on the Identify Risks process; since it is the main risk management step applied in this research.

The research used the expert interview method and review of existing literature research to identify external risks in Saudi power generation projects. It also highlighted the main external risks, in the Saudi construction industry, identified in almost all of the main studies conducted in the past 20 years.

Through ten expert interviews, 101 responses were received. 88 of which identified 27 threats in Saudi Power Generation projects. Out of the 27 identified threats, 17 were major threats since they were highlighted by at least three experts. The most highly ranked threats, that were identified in this research, are:

- Availability of qualified manpower in Saudi Arabia
- Main client's contractual general terms and conditions
- Weather conditions in Saudi Arabia

The other 13 responses identified some opportunities in these projects. The main identified opportunities are:

- The Saudi economy is a free market and stable and growing economy
- Positive outlook for the Saudi power generation industry with many new planned projects to meet increasing demand

A comprehensive comparison between the results of the primary research and the literature review was completed. Many similarities were identified between the two findings.

Recommendations, that will help process the findings of this research further into the Risk Management Processes, include:

- A risk register must be built to keep and track risk information.
- Identified risks must be analyzed, their root causes, triggers, and effects must be defined. The extent of their impacts must also be identified.
- Preliminary responses shall always be added to the risk register as they are identified.
- Each major risk should be assigned to a risk owner.
- All of this new data should be added to the risk register, monitored, and updated as the project progresses.

Finally, further studies that could be developed based on the results of this research, were suggested by the author.

CHAPTER 1 – INTRODUCTION

All projects are risky undertakings as a result of their common characteristics and because of the *external environment* within which they are undertaken.[1] [2] Managing project risks is a major driver of the success of any project, a Saudi Power Generation Project is no exception. Unfortunately, a risk cannot be managed unless it's controlled; and it cannot be controlled unless it's measured; and it cannot be measured unless it's identified. That is why planning risk management activities and identifying individual risks are the first two steps in the risk management process.

1.1 Purpose of the Research

1.1.1 Research Objectives

This research implements a single technique to partially complete the second step of the project risk management process, which is Identify Risk Process. It focuses only on identifying external risks that could affect a Saudi Power Generation Project. By interviewing experts, who worked on Saudi generation projects, the author identified specific risks that are caused by the external environment and could cause a positive or negative effect on a Saudi power generation project. Hence, the risks identified based on the external originate due to the project environment rather than the internal aspects.[3] [4]

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[1] David Hillson, *Managing Risk in Projects*, Fundamentals of Project Management (Farnham, England Burlington, VT: Gower, 2009), xv.
[2] Ibid., 17.
[3] Siaw Chuing Loo et al., "Managing External Risks for International Architectural, Engineering, and Construction (Aec) Firms Operating in Gulf Cooperation Council (Gcc) States," *Project Management Journal* 44, no. 5 (2013).
[4] Examples of these international studies are: Aleshin (2001); Wang and Chou (2003); Fang, Li, Fong, and Shen (2004); Thuyet, Ogunlana, and Dey (2007); and El-Sayegh (2008).

Therefore, the purpose of this research is to answer the question: "What are the potential *external* risks and opportunities that could impact a Saudi Power Generation Project?" Identifying and exposing project risks will help in developing the appropriate and most effective responses. Also, positive risks i.e. opportunities, when identifying, will be exploited or shared by all parties associated with the project.

The Project Management Institute's (PMI) standard for project management, which is elaborated in the *Guide to the Project Management Body of Knowledge (or PMBOK® Guide)*, would sort the proposed work done in this research under the risk management knowledge area (Chapter 11) and will include its activities within the second step of Project Risk Management Processes, i.e. Identify Risks Process (Section 11.2). [1]

1.1.2 Research Limitations

This research has some limitations which can be considered as suggestions for future works in this area. The first limitation is that this research applies only one step of project risk management, which is the Identify Risks Process. Secondly, it uses only two techniques as its methods for identifying risks, which are the expert interviewing technique and the prompt list technique. Also, it doesn't identify internal risks that arise from within the project itself and are caused by the project's elements such as systems interfaces, utilization of a new technology and the level of implementation of risk management in the project. Other areas that are not addressed in this research are:

[1] Project Management Institute., *A Guide to the Project Management Body of Knowledge (Pmbok Guide)*, Fifth edition. ed. (2013).

identifying root causes of risks, nominating potential risk owners, and listing potential responses and risk triggers for each risk[1].

Finally, the research focuses only on one type of Saudi construction project; that is a Saudi Power Generation Project. Nonetheless, it is one of the largest and most complex types of construction projects that are currently executed in Saudi Arabia. In other words, a Saudi Power Generation Project can be considered as a representative example of a Saudi construction project.

1.1.3 Author's Objectives

This research is the author's graduation field project for the degree of Master of Science in Engineering Management. Even so, to complete the research, the author had to learn interviewing best practices. Since interviewing technique is the sole methodology for the primary research.

Moreover, the research enriched the author's engineering management knowledge, as well as his work experience, through the identification of risks in Saudi Power Generation Projects and interviewing many subject matter experts.

In addition, the research approach and methodology as well as the secondary research contributed to the author's learning in relation to:

- Power Generation Projects, including their types and characteristics,
- Saudi construction market conditions, and
- Risks that could affect a Saudi Power Generation Project, including their probable causes and expected impacts.

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[1] Project Management Institute., *Practice Standard for Project Risk Management* (Newtown Square, Pa.: Project Management Institute, 2009).

1.1.4 Beneficiaries

The process of identifying project risks, by itself, will reduce project uncertainty, since risks that are identified are less likely to occur because they have changed from being unknown unknowns and became known unknowns. In other words, simply identifying risks will decrease the overall risk for the project.[1]

Identifying and exposing project risks will also help project participants to be aware of the risks, their immediate causes, and potential responses. This will reduce project uncertainty for the main contractor (seller), as well as its allocated contingency reserves. Such reduction in uncertainty and reserves will also benefit the client (buyer) in the form of a lower project cost budget.

Therefore, sellers, such as Engineering Procurement Construction (EPC) Contractors, Subcontractors, Engineering Consultants, Project Management Firms, and Original Equipment Manufacturers (OEM) will most likely benefit from the results of this research since a Saudi Power Generation Project is just another Saudi construction project and has a very similar external environment, if not identical. Moreover, potential foreign entrants will be able to plan how to manage these risks before entering the Saudi Industrial Market.

On the other hand, clients or end users, such as the Saudi government, semi-governmental organizations, and large industrialized organizations in the Saudi private sector, will benefit from this research. For example, the Saudi Government could use the results of this research in order to eliminate the root causes of the identified risks and improve the overall Saudi Business Environment. A semi-governmental organization can

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[1] Rita Mulcahy and Rita Mulcahy, *Risk Management Tricks of the Trade for Project Managers : And Pmi-Rmp Exam Prep Guide*, 2nd ed. (Minnetonka, Minn: RMC Pub., 2010), 87.

improve its current procedures and requirements to avoid those risks entirely. It can also help its main contractors overcome some of these risk by taking certain measures to reduce the probability of those risks occurring. Major private industrialized organizations, can also make intelligent investments in resources that could reduce the impacts of these risk in case they occurred. For example, they can build a strong partnership with a local logistics handling firm to help facilitate any custom clearance problems that could impact the project.

Moreover, other project management practitioners who are involved in managing or executing a power generation project anywhere in the world, could utilize the method presented in this research as well as its results as a starting point and as a guide to complete similar research in any other country.

Finally, some researchers who are interested in the risk management area of research may find the result of this research very helpful.

1.1.5 Report Outline

The report is arranged in six chapters. Chapter one is an introduction chapter that gives a general review of the Power Generation Projects in Saudi Arabia, research objectives, research's scope and limitations, and the significance of the study.

Chapter two covers the literature review of the available work reported on the subject of risks in Saudi Power Generation Projects as well as Saudi Construction Projects with emphasis on identified external risk as well as their significance and ranking.

Chapter three describes the research procedures. It outlines the research method, i.e. expert interviewing, its advantages and disadvantages, and interviewee selection criteria.

Chapter four lists the outcomes of the primary research, describe identified external risks in Saudi Power Generation Projects in details, and will analyze the results of the research.

Chapter five contains suggestions for further studies and additional work that will be based on the findings of this research.

Finally, Saudi Electrical Data, interview introduction and questions, references used for the research, and a list of all risks in Saudi construction industry, identified through literature review, are collected in the report's appendices.

1.2 Project Risks Management

Projects that succeed generally do so because their leaders do two things well: First, leaders recognize that much of the work on any project is not new. For this work, the notes, records, and lessons learned on previous projects can be a road map for identifying, and in many cases avoiding, many potential problems. Second, they plan project work thoroughly, especially the portion that requires innovation, to understand the challenges ahead and to anticipate many of the risks.[1]

[1] Tom Kendrick, *Identifying and Managing Project Risk : Essential Tools for Failure-Proofing Your Project*, 2nd ed. (New York: AMACON, 2009), 2.

1.2.1 Project Risk

The Project Management Institute defines a Project Risk as *an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives.*[1] This definition includes two key dimensions of risks: uncertainty and effect on a project's objectives. When assessing the importance of a project risk, these two dimensions must both be considered. The uncertainty may be described using the term "Probability" or "Likelihood" and the effect may be called "Impact" or "Consequence".[2]

However, a project risk includes the possibility of loss or gain, or variation from a desired or planned outcome, as a consequence of the uncertainty associated with following a particular course of action. These two types of risks are called threats (losses) and opportunities (gains).[3]

1.2.2 Project Risk Management

The Project Risk Management Process is a systematic and a proactive approach to taking control of projects by understanding or decreasing uncertainties (unknowns).[4] It includes, the processes of conducting risk management planning, identification, analysis, response planning, and controlling risk on a project. The objectives of project risk

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[1] Project Management Institute., *A Guide to the Project Management Body of Knowledge (Pmbok Guide)*, 310.
[2] Project Management Institute., *Practice Standard for Project Risk Management*, 09.
[3] Dale F. Cooper and Broadleaf Capital International., *Project Risk Management Guidelines : Managing Risk in Large Projects and Complex Procurements* (West Sussex, England ; Hoboken, NJ: J. Wiley, 2005), 03.
[4] Rita Mulcahy and Rita Mulcahy, *Rita Mulcahy's Risk Management Tricks of the Trade for Project Managers : And Pmi-Rmp Exam Prep Guide : A Course in a Book*, 2nd ed. (Minnetonka, Minn: RMC Pub., 2010), 2.

management are to increase the likelihood and impact of positive events, and decrease the likelihood and impact of negative events in the project.[1]

Project Risk Management should be conducted in a way that is appropriate to the project. It should recognize the business challenges as well as the multi-cultural environment associated with an increasingly global environment including many joint venture projects and customers, suppliers, and workforces spread around the globe.[2]

1.2.3 Project Risk Management Processes

Project Risk Management is a structured approach for understanding and managing risk on a project. It is described by six defined steps. It starts with an initiation step that ensure a common understanding and agreement of the team and other stakeholders on the approach and parameters that will be applied in managing risk in the project, as well as the scope and objectives of the Project Risk Management Process itself. The output of this step is known as the "*Project Risk Management Plan*."

The following step is identifying project risks. One or more risk identification techniques are selected as appropriate for meeting the needs of the specific project. The aim is to expose and document all known risks, recognizing that some risks unknowable until exposed latter in the project. The output of the Identify Risks step is a risk register which is a record of all identified risks. It also specifies the designated owner for each risk.

Afterward, all identified risk has to be evaluated, in terms of their likelihood and potential impact, in order to *prioritize* them for further attention. During this step, the level of the

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[1] Project Management Institute., *A Guide to the Project Management Body of Knowledge (Pmbok Guide)*, 309.
[2] Project Management Institute., *Practice Standard for Project Risk Management*, 5.

overall project risk can be determined. However, risk evaluation can be completed using qualitative techniques, or quantitative techniques, or using a combination of both.

Based on the qualitative and/or quantitative analysis, appropriate risks responses should be developed using an iterative process to put in place an optimal set of responses that will avoid, transfer, or mitigate all highly-ranked risks.

The final project risks management step is to monitor and control all risks in the projects by implementing agreed-upon actions, reviewing changes in project risk exposure, identifying additional risk management actions and assessing the effectiveness of the Project Management Process[1].

The steps described previously forms the six Project Risk Management Process. They are defined by the PMBOK® Guide as follows:

1) **Plan Risk Management:** The process of defining how to conduct risk management activities for a project
2) **Identify Risks:** The process of determining which risks may affect the project and documenting their characteristics.
3) **Perform Qualitative risk Analysis:** The process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact.
4) **Perform Quantitative Risk analysis:** The process of numerically analyzing the effect of identified risks on overall project objectives.
5) **Plan Risk Responses:** The process of developing options and actions to enhance opportunities and to reduce threats to project objectives.
6) **Monitor and Control Risks:** The process of implementing risk responses plans, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating risk process effectiveness throughout the project.

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[1] Ibid., 14-16.

It is worth mentioning that the *PMBOK® Guide* is built around five Project Process Groups: *Initiating, Planning, Execution, Monitoring and Controlling, and Closing.* Figure 1 (below) shows how the Project Process Groups are related and how the six steps of Project Risk Management are divided between these Groups.

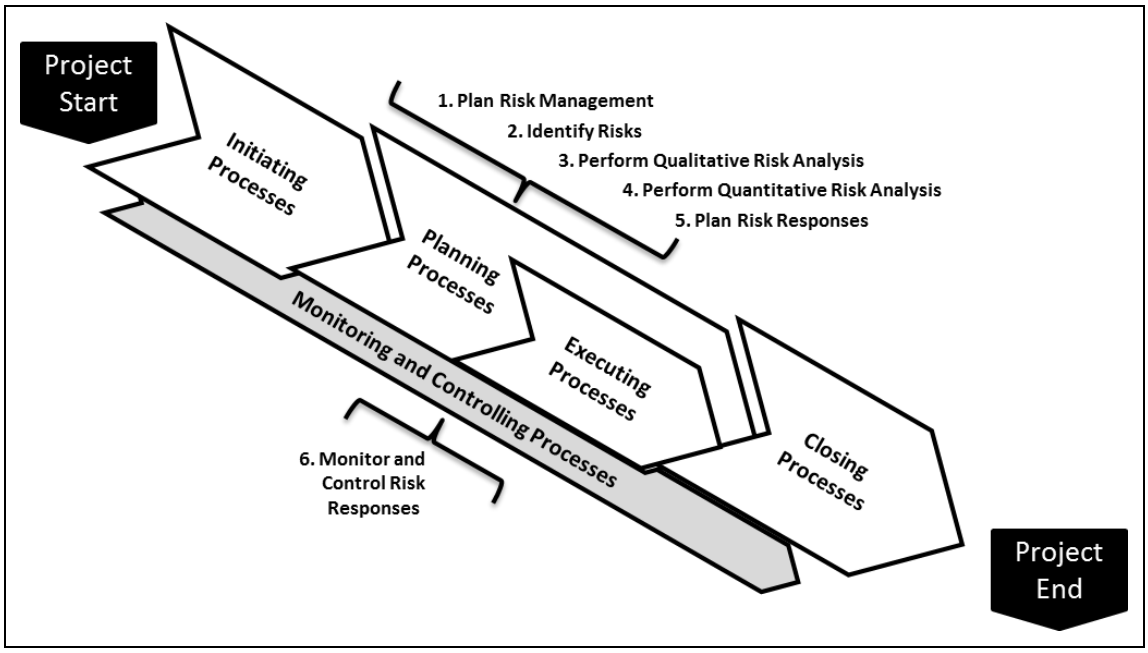

Figure 1 : PMI PMBOK® Links Among Process Groups

Sources: Identifying and Managing Project Risk: Essential Tools for Failure-Proofing Your Project, 2nd ed, 2009

1.3 The Identify Risks Process

1.3.1 Definitions

The International Organization for Standardization defines any process as *a set of interrelated or interacting activities which transforms inputs into outputs*[1]. Similarly, the Project Management Institute defines a process as *a systematic series of activities*

[1] ISO 9000:2005, Quality management systems — Fundamentals and vocabulary

directed towards causing an end result such that one or more inputs will be acted upon to create one or more outputs[1]. Figure 2 (below) shows the workflow diagram for a generic process.

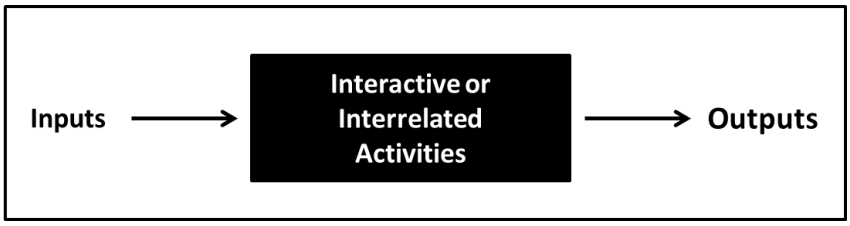

Figure 2: A Process Workflow Diagram

Like any other process, the Identify Risks Process has some inputs, methods, also known as tools and techniques, and output(s). Its main function is to determine which risks may affect the project and documenting their characteristics. By applying its methods, the project participants can determine what might happen that could affect the objectives of the project, and how those things might happen.[2] Its purpose is to identify risks to the maximum extent that is practical.

1.3.2 Process Inputs

The Information used as inputs to the risk identification process may include historical data, theoretical analysis, empirical data and analysis, informed opinions of the project team and other experts, and the concerns of stakeholders.[3] The *PMBOK® Guide* is more specific. It suggests the following inputs:

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[1] Project Management Institute., *A Guide to the Project Management Body of Knowledge (Pmbok Guide)*, 551.
[2] Cooper and Broadleaf Capital International., 37.
[3] Ibid.

1. Risk management plan
2. Cost management plan
3. Schedule management plan
4. Quality management plan
5. Human resource management plan
6. Scope baseline
7. Activity cost estimates
8. Activity duration estimates
9. Stakeholder register
10. Project documents
11. Procurement documents
12. Enterprise environmental factors
13. Organizational process assets

1.3.3 Tools and Techniques for Risks Identification

There are many tools and techniques that are used to identify project risks. The *PMBOK® Guide* lists seven of them[1]:

1. Information gathering techniques, including, but not limited to:
    - Brainstorming
    - Delphi technique
    - Interviewing
    - Root cause analysis
2. Project Document reviews
3. Checklist analysis
4. Assumptions analysis
5. Diagramming techniques
6. SWOT analysis
7. Expert judgment

The PMI Practice Standard for Project Risk Management adds other methods to the one listed in the *PMBOK® Guide* such as **Prompt Lists**, and Risk Breakdown Structure.

[1] Project Management Institute., *A Guide to the Project Management Body of Knowledge (Pmbok Guide)*, 324-327.

The methods used in this research is a combination of the Interview and Prompt-Lists techniques. More on the methods used in this research can be found in Chapter three, Research Procedure.

1.3.4 Process Outputs

The results from the Identify Risks process should be recorded in order to capture all relevant information available for each identified risk. The *main output* from the Identify Risks process is the risk register, which includes detailed description of all identified risks as well as the nominated risk owner for each risk. It may, also, include information on the causes and effects of the risk, trigger conditions, and potential responses.[1]

The inputs, tools and techniques, and outputs of this process are depicted in Figure 3 below.

[1] Project Management Institute., *Practice Standard for Project Risk Management*, 29.

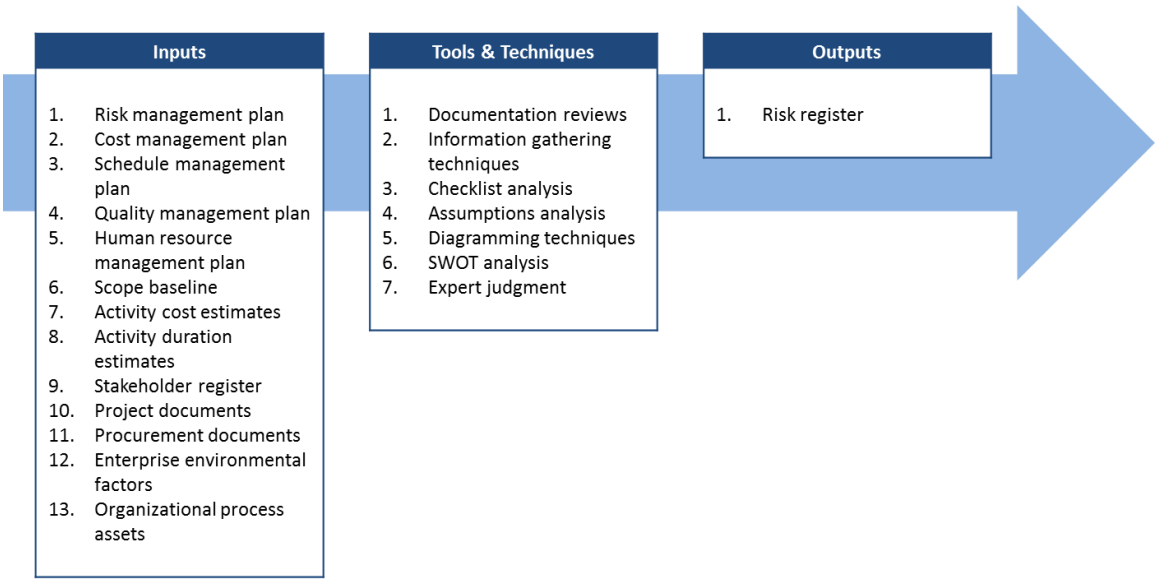

Figure 3: Identify Risks: Inptus, Tools & Techniques, and Outpus

Source: PMI PMBOK®

1.3.5 Success Factors for the Identify Risks Process

The following practices, if applied correctly, will maximize the value and effectiveness of the Identify Risks process and enhance the likelihood of identifying as many risks as possible.[1]

1.3.5.1 Early identification:

Early identification of project risks enables key project decisions to take maximum account of risks inherent in the project, and may result in changes to the project strategy. It also maximizes the time available for development and implementation of risk responses.

[1] Ibid., 25.

1.3.5.2 Iterative identification

Because new risks may evolve or become known as the project progresses, the Identify Risk process has to be iterative in order to develop a comprehensive list and to find new risks which have become known since the previous iteration of the process.

1.3.5.3 Emergent identification

Risks should be identified at any time, not limited to formal risk identification events or regular reviews.

1.3.5.4 Comprehensive Identification

A broad range of sources of risk should be considered to ensure that as many uncertainties as possible that might affect objectives have been identified.

1.3.5.5 Explicit identification of Opportunities

Opportunities should be properly considered.

1.3.5.6 Multiple Perspectives

Inputs to the Identify Risks process should be taken from a broad range of project stakeholders to ensure that all perspectives are represented and considered.

1.3.5.7 Risks Linked to Project Objectives

Each identified risk should relate to at least one project objective (time, cost, quality, scope, etc.). Consideration of each project objective during the Identify Risks process

will assist in identifying risks. Nonetheless, some risks may affect more than one objective.

1.3.5.8 Complete Risk Statement

Identified risks should be clearly and unambiguously described, so that they can be understood. More detailed risk descriptions are required which explicitly state the uncertainty and its causes and effects.

1.3.5.9 Ownership and Level of Detail

Describing risks in a lot of detail can create a great deal of work. On the other hand, a generalized or high-level description of risk can make it difficult to develop responses and assign ownership. Hence, each risk should be described at a level of detail at which it can be assigned to a single risk owner with clear responsibility and accountability for its management.

1.3.5.10 Objectivity

Since Identifying Risks is a human activity, then it can be subject to bias. This should be recognized and addressed during the Identify Risks process. Sources of bias should be exposed and their effect on the process should be managed proactively. The goal is to minimize subjectivity, and allow for the identification of as many risks as possible.

1.4 Saudi Power Generation Projects

The Saudi Electricity Company (SEC) is the major provider of electric power all over the Kingdom of Saudi Arabia, serving government, industrial, agricultural, commercial and residential consumers. SEC was established in 5 April 2000 as a Saudi Joint Stock Company. It is registered in Riyadh, the capital of Saudi Arabia, under Commercial Registration Number 1010158683, dated 28 Muharram 1421H corresponding to 3 May 2000.

74.3% of SEC shares are owned by the Saudi Government, 6.9% is owned by Saudi Aramco, and 18.8% is publicly shared. By end of 2013 SEC total Assets reached $73.8B with a Shareholders' Equity of more than $11,11B.[1]

The Vision of SEC is "to help and improve the standards of living and to enhance the economic competitiveness of Saudi Arabia." Its Mission is to be committed to provide its customers with safe and reliable electric services, to meet the expectations of its shareholders, caring for its employees, and ensuring optimum utilization of available resources.

1.4.1 SEC Installed Power Generation Capacity

The total amount of energy produced by SEC power plants in 2013, is about 198,900 Giga-Watt Hours (GWh), with 4.0% decrease from 2012. However, the company's total Installed Power Generation Capacity increased from 43,083 MW in 2012 to 45,908 MW in 2013.[2] Figure 4 (below) shows SEC Power Generation map.

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[1] Saudi Electticity Company SEC, *Financial Statements 2013* (2014), https://www.se.com.sa/en-us/Pages/FinancialStatements.aspx.

[2] Saudi Electticity Company SEC, *Annual Report 2013* (2014), https://www.se.com.sa/en-us/Pages/AnnualReports.aspx.

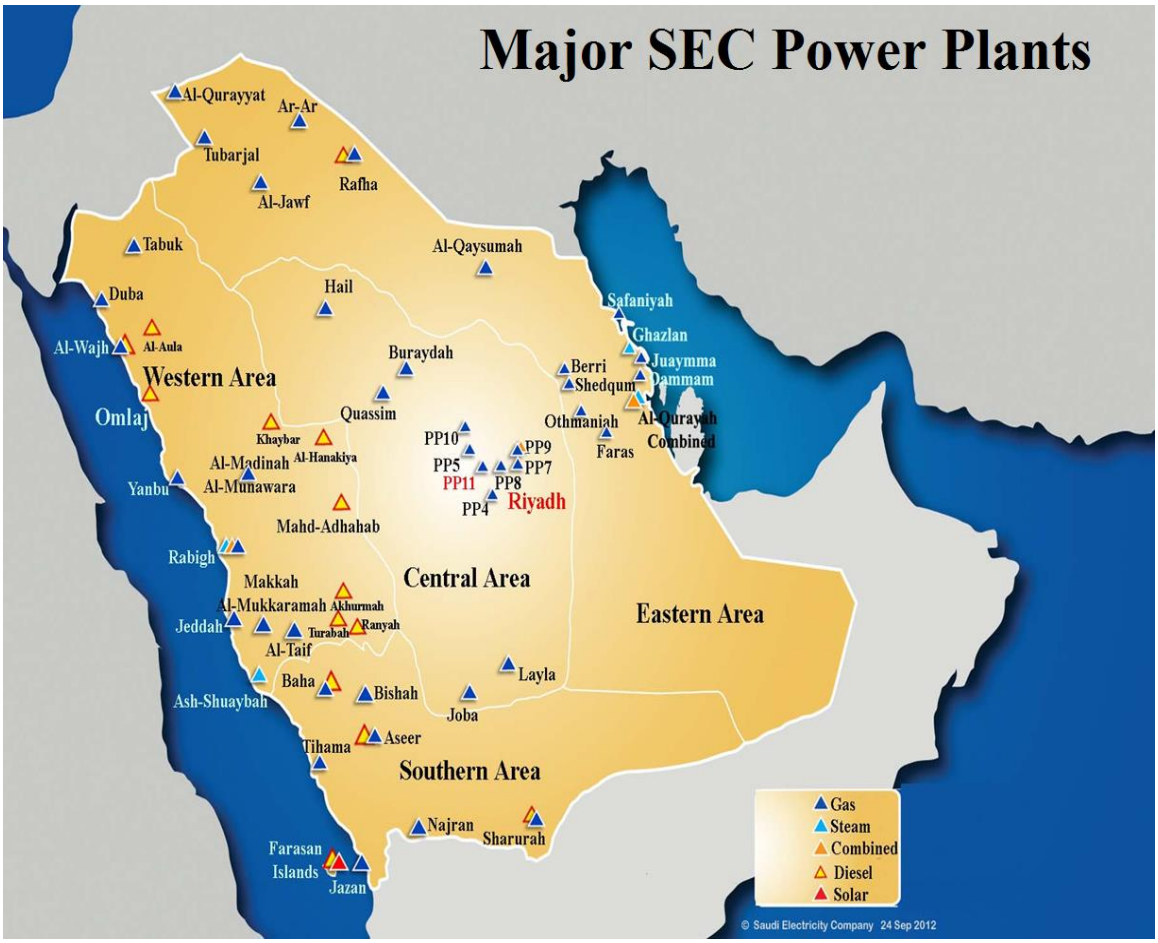

Figure 4: SEC Power Generation Map [1]

Almost all of SEC's power generation plants operates on fossil fuel including Heavy fuel oil, crude oil, and natural gas. Table 1 (below) illustrate the types of fuels used in SEC Power Generation Plants and their percentages. Also, Figure 5 (below) shows Relative Distribution of Fuel Consumed during 2013.

[1] Information and Regulatory Indicators Department SEC-IRID, "Electrical Data 2000 - 2013," (Saudi Electricity Company, 2014).

Type of Fuel	Gas	Crude Oil	HFO	Diesel	Total
Fuel Consumed 1000*(TOE)	21338	16242	3766	11792	55205
Percent	40.20%	30.60%	7.10%	22.20%	100%

Table 1: Fuel Consumed by Type During 2013[1]

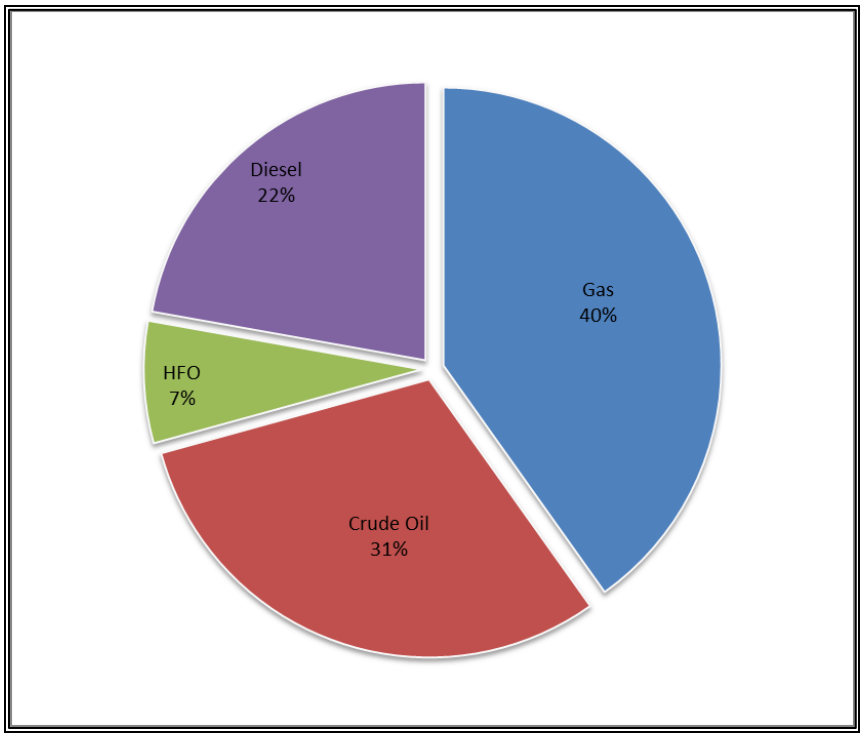

Figure 5: Relative Distribution of Fuel Consumed During 2013[2]

Although SEC is the sole electrical utility company in the country, it is not the only producer of electrical energy. There are other producers of electricity such as Independent Power Producers (IPP) and Saudi Arabia's Saline Water Conversion Corporation (SWCC). Figure 6 (below) shows the relative distribution of Transmitted Energy during 2013 according to the source.

[1] Ibid.
[2] Ibid.

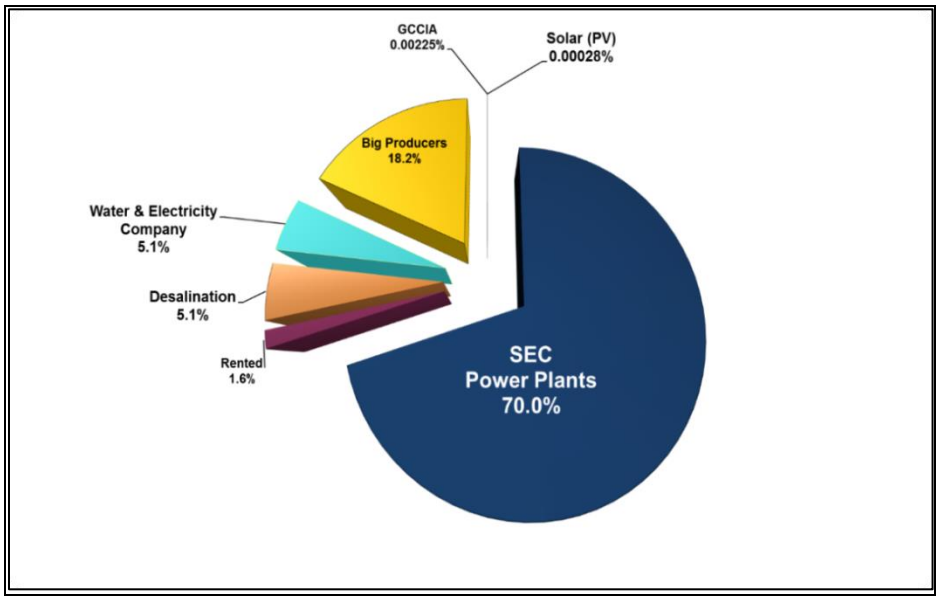

Figure 6: Relative Distribution of Transmitted Energy According to the Sources 2013 [1]

Also, Figure 7 (below) shows the contribution of other producers at the Peak Load during (2012 – 2013).

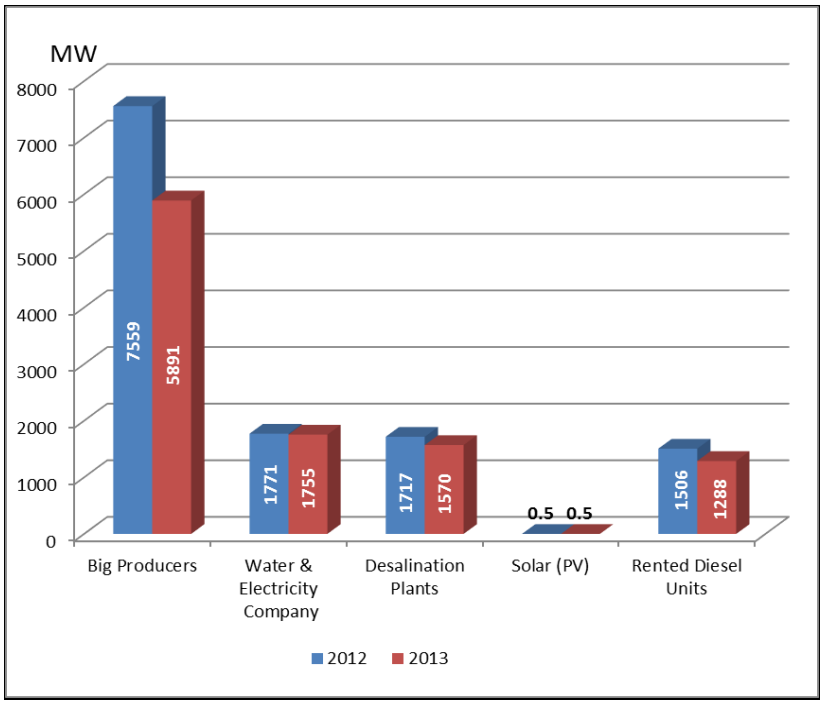

Figure 7: Contribution of Other Producers at the Peak Load During 2012 – 2013[2]

[1] Ibid.
[2] Ibid.

1.4.2 SEC Power Generation Technologies

SEC uses mainly four technologies in its power generation plants. The first technology is Diesel engines which operate on Diesel. The second is Gas Turbines which normally operate on Natural Gas, Arabian Super Light Crude Oil (ASL), and Diesel. The third is Steam Turbines (Thermal) which operate on steam derived from Heavy Fuel Oil (HFO) and Crude Oil Boilers. The fourth technology is the Combined Cycle technology which is a combination of Gas Turbines and Steam turbines. The Combined Cycle Power Plants (CCPP) operate on similar fuels as the Gas Turbines and the exhaust heat from the Gas Turbines is used to generate steam and run the steam turbines. Figure 8 (below) shows the Development of Actual Generation Capacity by type of units during (2000-2013).

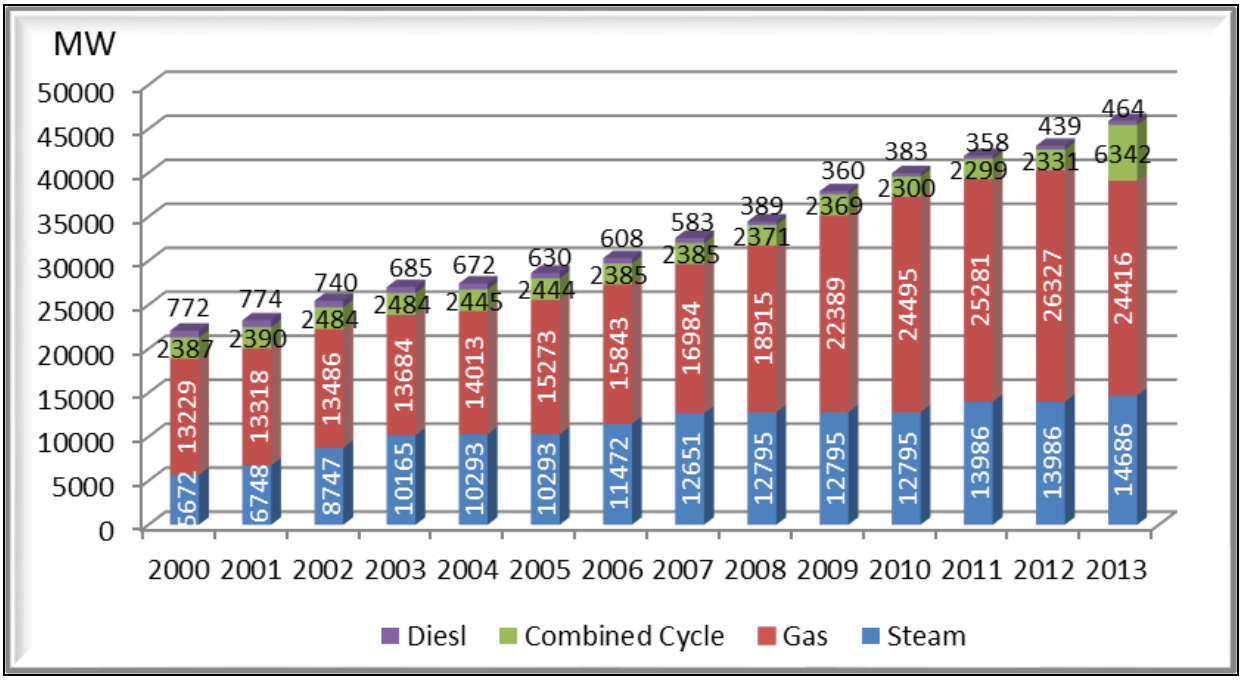

Figure 8: Development of SEC Actual Generation Capacity by Type of Units (2000-2013)[1]

[1] Ibid.

1.4.3 SEC Power Generation Project Definition and Life Cycle

1.4.3.1 Definition

For a better capital utilization and for a higher operating efficiency, SEC builds only large size power plants. Then, it uses its massive power transmission network (Power Grid) to connect these power plants together and to the consumers. Hence, all of SEC new power generation projects are mega construction projects. Each is a multimillion, if not multibillion, dollar project with an execution period of two to four years.

Because of the complexity of its power generation projects, and to transfer technological risks, SEC uses the lump sum turn-key contracts (LSTK) to build its power plants. That is why only qualified Engineering Procurement Construction (EPC) Contractors are allowed to participate in these projects.

1.4.3.2 Life Cycle

A SEC Power Generation Plant project goes through four (4) main phases: Initiation, Development, Engineering & Tendering, and Execution. In the initiation phase the forecasted power demand (MW) needed by the consumers in a certain area is identified. Based on the location and the nature of the area, the power generation technology will be selected. For example, all thermal power plants are located on the country's two coast, the East and West Coasts. This is because of the availability of water. Another factor that influence the technology selection is the type of available fuel. For example, HFO can only be used in thermal conventional power plants. The output of the initiation phase is the estimated size of the power plant in Mega Watt (MW), its approximate location, the type of technology to be utilized, and the fuel type.

The Development phase will then focus on securing the proper land as well as the quantities of fuel needed to operate the power plant throughout its production life cycle.

SEC will then develop the preliminary design and prepare the tender documents. This last step is usually completed with the help of an international engineering consultancy firm. The output of the Engineering & Tendering phases is a complete tender documents with a clearly defined Scope of Work (SOW). Pre-qualified EPC Contractors will then be invited to participate in the tendering process. The bidder with the Lowest Compliant Price (LCP) will be awarded the contract. The land is then handed over to the EPC contractor to start the execution phase of the project.

Simultaneously, SEC will also invite pre-qualified engineering consultancy firms for another tender. This time the scope of work will be the Owner Engineer. The Owner Engineer will supervise the selected EPC contractor during the execution period and will ensure that the plant is being built according to the contractual specifications.

1.4.4 On-going and Future SEC Generation Projects

In its 7,436 issue (February 19, 2014) a well-known local newspaper, named Al-Eqtisadyah, reported that the volume of investment in the building and construction sector in Saudi Arabia is poised to jump to $300 billion by 2016 from the current level of $200 billion. Power Generation Projects form a major portion of Saudi construction projects and they are some of the largest. For example, two EPC contracts were signed in 2013 to build two 2,600 MW thermal power generation plants in Jeddah City and ALShugaig City, respectively. The two contracts total to $6.45 Billion.

Table 2 (below) summarizes the actual Generation Capacity added in SEC's Power Plants (MW) during 2013.

Plant Name	Unit Type	Capacity (MW)
Al Qurayah Combined	Combined Cycle	1000
Al-Qurayyat	Gas Turbines	120
Wadi Ad Dawasir	Gas Turbines	124
Ash-Shuaybah	Combined Cycle	760
Rabag 2	Steam Turbines	700
Tabuk 2	Gas Turbines	124
Al-Wajh	Gas Turbines	180
Najran	Gas Turbines	112
Total		3120

Table 2: Actual Generation Capacity Added in SEC's Power Plants (MW) During 2013[1]

Also, the total number of generation projects under implementation during 2012 is 15 projects as follows.[2]

- 13 projects to create new plants and expansions of total capacity (11,200 MW) at a total cost of $13,522.9 million
- 2 fuel Transmission lines projects at a total cost of $153.9 million.

Moreover, as part of its electrical system plan for the coming ten years, SEC is working on improving the efficiency of existing power plants as well those of future power plants.

[1] SEC, *Annual Report 2013*.
[2] Saudi Electricity Company SEC, *Annual Report 2012* (2013), https://www.se.com.sa/en-us/Pages/AnnualReports.aspx

The plan includes converting gas power plants to a combined-cycle system, the benefits of which are:

- Increasing the generating capacity in these plants by 50% without adding fuel, thus cutting down the proportion of emissions from burning fuel. This has a positive impact on reducing air pollution and preserving the environment.
- Increasing the thermal efficiency of the plants that run on crude oil from about 28% to about 44% and stations that run on gas fuel to 54%, after conversion to a combined-cycle.
- Using the supercritical boiler technology. The high efficiency of this technology reduces fuel consumption compared to conventional (Subcritical) boilers. This technology will be used in all future boiler project stations.

Therefore, over the next ten years Saudi Electricity Company plans to add 27,768 MW to its power generation capacity. It is expected to save 44 million barrels a year by converting invasive plants to combined-cycle and the use of supercritical technology.[1]

As per SEC plan, the new 27,768 MW will be generated as per the following:

- Steam stations projects: (20,400 MW).
- New combined-cycle plants projects: (3,600 MW).
- Conversion projects (10) to combined-cycle plants (3,768 MW).

Appendix-A provides historical annual power generation data covering the last 14 years (2000-2013).[2]

[1] Ibid.
[2] SEC-IRID.

CHAPTER 2 - LITERATURE REVIEW

2.1 Introduction

During his secondary research step, the author was unsuccessful in finding research papers that investigated the environmental risks (external) that could affect a Saudi power generation project except for one study that was completed in the 1970s. Other papers that identified external risks in the same type of industry, i.e. power generation project, were found, but they were not cited in this report. This is because of the following two reasons:

- These papers were focused on other countries which have totally different external environment than Saudi Arabia. Hence the risks identified are irrelevant to the subject of this research.
- Most of the identified risks were financial in nature and reflected the effect of a country's market conditions on a power generation project.

Nonetheless, Saudi power generation projects are just another Saudi construction project. Actually, they can be considered as a representative example of Saudi construction projects because of their sizes and complexity. Therefore, the author reviewed almost all main studies that tried to identify external risks in Saudi Construction Projects.

2.2 External Risks in Saudi Power Generation Projects

As a case study of executing a turn-key engineering project in a transnational environment, Mr. Bajaj and Mr. Agrawal described their experience in executing a turn-key power project in Gizan, Saudi Arabia in the late 70's.[1] Their paper identified some of the challenges that faced the project as well as the methods implemented by the project team to overcome those challenges.

The scope of Gizan power project included the construction of six units of seven megawatt Diesel Engine Power Station (6x7 MW DPP), 33 KV overhead lines, 33/13.8 KV stations, 13.8 KV distribution lines, and 13.8 KV/220V distribution substations in villages and small towns. Project scope also included laying of 220 Volts lines with consumer connections to more than 8000 households.

Mr. Bajaj and Mr. Agrawal identified the flowing external risks in Gizan power generation project:

1. The Saudi environment is a transnational environment, where more than ten nationalities are usually involved in a major power generation project.
2. For most EPC contractors, Saudi environment is unfamiliar one and the means of communication are not reliable.
3. Some of Saudi Power generation projects are in the desert, where facilities and standard means of living are not available.
4. The country has visa restrictions, which needed suitable advance actions to avoid project delay.
5. Currency fluctuations added another dimension of uncertainty.

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[1] H. L. Bajaj and A. Agrawal, "Experience in Execution of a Turnkey Power Project in a Transnational Environment," in *Engineering Management Conference, 1993. Managing Projects in a Borderless World. Pre Conference Proceedings., 1993 IEEE International* (1993).

6. Availability of sizable seaports as well as broad and strong roads for the shipment and transportation of equipment to the project site are very important to the success of the project.

Most of the challenges described in Mr. Bajaj's paper are still applicable to today's Saudi environment; however, some of the identified risks are no longer relevant. For example, having an effective, fast and reliable means of communication with all the agencies involved in the project is no longer a major challenge in the Saudi environment because effective and reliable communication channels can now be established even in a remote Saudi desert. Satellite communication is one example of such channels. Also, the Saudi currency has been pegged to the US Dollar for many years and it is still the current policy of the Saudi Government. Such a fact almost eliminates the risk of currency fluctuations. In addition, the infrastructure required for the shipment and transportation of equipment to a project site was developed in the past 25 years.

2.3 External Risks in Saudi Construction Projects

2.3.1 Al-Barrak's Study

A graduate student of King Fahd University of Petroleum & Minerals, Eng. Adel ALBarrak, presented in 1993 a thesis that discusses the main causes of failure in the construction industry in Saudi Arabia.[1] A survey of 68 contractors from the entire country was conducted. The survey included 34 different causes of failure and their degree of importance. The severity factors of these causes were measured by their level of importance and were ranked according to the severity index.

[1] Adel Abdulaziz Al-Barrak, "Causes of Contractors' Failures in Saudi Arabia" (M.S., King Fahd University of Petroleum and Minerals (Saudi Arabia), 1993).

Causes included in the questionnaire were divided into four groups, namely, managerial, financial, expansion, and environmental (*external*) causes. Only four environmental causes were listed in the questioner. The study concluded that lack of experience in the line of the work, neglect, poor estimation practices, bad decisions in regulating company's policy, and national slump in the economy are the most severe factors.

The four environmental causes, which amount for 23.7% of the total weighted feedback, are listed below in the order of their severity:

- National Slump in the Economy (the fifth most important cause of failure)
- Construction Industry Regulation in Saudi Arabia (the 13th most important cause)
- Owner Involvement in Construction Phase
- Bad Weather

It is worth mentioning that ALBarrak's survey was conducted right after the second Gulf War, also known as Kuwait Liberation War. In that period of time, government spending was limited and the fiscal policy was on the other end of being expansionary.

The only limitation of ALBarrak's study is that all causes were suggested by the researcher based on a pilot study. Respondent had to rank what was presented to them. Nonetheless, some respondent specified other causes of project failure. These other causes are Lack of relationship between the management and labor force, tendency to recruit low payment, recruitment procedures and options, good name in the market, project follow up, and low company capital.

2.3.2 Al-Harbi's Study

In 1993, another study was conducted to investigate estimating practices in Saudi Arabia's Building Construction Market.[1] Although the purpose of the study was to identify the basic building estimating process, problems, and items needed in developing cost estimates for Saudi Building Construction projects, the researchers pointed out some external risks that need to be account for when preparing an estimate for a Saudi construction project.

The first external risk was the fact that there is no standard of measurement for Saudi Arabia. Systematic items and descriptions are not available. To mitigate such as risk, some Estimators try to keep their own costs databases. Other estimators use cost sources, such as Means and Richardsons to obtain labor and equipment productivities. However, they adjust to local conditions by multiplying by a factor, usually 0.5.

The second risk that was highlighted by the study, conducted by Mr. Al-harbi, Mr. Johnston, and Mr. Fayadh, is the government tender regulations that call for calculating estimates in Saudi Riyals and paying in U.S. dollars, for any contract over SR300,000,000.[2]

Also, in lump sum bids, if a Bill of Quantity (BOQ) is included, most Saudi clients have a waiver exempting them from responsibility for the correctness of quantities. Accordingly, the BOQ must be thoroughly checked by estimators.

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[1] Kamal M. Al-harbi, David W. Johnston, and Habib Fayadh, "Building Construction Detailed Estimating Practices in Saudi Arabia," *Journal of Construction Engineering and Management* 120, no. 4 (1994).

[2] Unless otherwise mentioned, all currency values are at present values of their published date (1 U.S. dollar = 3.75 Saudi Riyal)

Moreover, all equipment and materials imported from outside the country need to be in accordance with the standards of the Saudi Arabian Standards Organization (SASO). Custom officials will not accept imported items that do not comply. All dimensions must be in metrics. The contractor is responsible even if the consultant indicates otherwise in specifications, or approves working drawings that do not comply with SASO standards.

Another risk that was alluded to by the above study is the availability of the local subcontractors. Because Saudi construction tenders requires that 30% of work awarded to foreign contractors is to be subcontracted to 100% Saudi-owned companies.

The final external risk that was mentioned in the research is that tender regulations holds the contractor responsible for partial or total collapse of whatever is built, for a period of 10 years. Hence, additional cost must be included to pay for checking the design of critical parts of the buildings and to pay for insurance to cover the 10-year period.

2.3.3 Assaf's Study

Also, Mr. Assaf, Mr. Al-Khalil, and Mr. Al-Hzami conducted another study, in the mid-nineties, to identified 56 causes of delay in large building projects in Saudi Arabia. They reviewed relative literature and interviewed local contractors, architectural/engineering firms (A/Es), and owners.[1] The scope of their research was limited to large public building projects in the Eastern Province of Saudi Arabia, that are over US$2.6 million in value.

A survey was then conducted to assess the relative importance of the causes. The researchers found that contractors, consultants, and owners generally agree on the importance ranking of delay factors. Contractors considered the most important delay factors to be the preparation and approval of shop drawings, design changes, and payment delay by owner. The most important delay factors as seen by the consultants were cash problems, contractor financing during construction, the relationship between different subcontractor schedules, and slow decision making by the owner. The owner considered the most important delay factors were design errors, excessive bureaucracy in project-owner organization, labor shortages and inadequate labor skills.

Table 3 (below) shows lists of main causes of delays as seen by the three parties. Delay factors, then, were grouped into nine categories from which financing was unanimously ranked highest. Table 4 (below) shows the highly ranked groups of delay factors as seen by the contractors, consultants, and owners.

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[1] Sadi A. Assaf, Mohammed Al-Khalil, and Muhammad Al-Hazmi, "Causes of Delay in Large Building Construction Projects," *Journal of Management in Engineering* 11, no. 2 (1995).

Rank	Most Important Delay Factors as Seen by:		
	Owners	**Contractors**	**Architectural / Engineering**
1	Design errors made by designers (due to unfamiliarity with local conditions and environment)	Preparation and approval of shop drawings	Cash problems during construction
2	Excessive bureaucracy in project-owner operation	Design changes by owner or agent during construction	Contractor financing during construction
3	Manpower Shortage	Delay in the special manufacture out of Saudi Arabia	Relationship between different subcontractors' schedules in execution of project
4	Labor Skills	Cash problems during construction	Slowness of owner's decision-making process
5	Financing by contractor during construction	Slowness of owner's decision-making process	Delays in contractors' progress payments by owner
6	Materials Shortage	Design errors made by designers (due to unfamiliarity with local conditions and environment)	Changes in types and specifications of materials during construction
7	Cash problems during construction	Slow delivery of Materials	Poor judgment and experience of involved people in estimating time and resources
8	Errors committed during field construction on site	Waiting for sample materials approval	Controlling subcontractors by general contractors in execution of work
9	Unavailability of professional construction management	Materials Shortage	Design changes by owner or agent during construction

Table 3: Rank of Most Important Delay Factors Identified in Assaf's Study[1]

Rank	Most Important Groups of Delay Factors as Seen by:		
	Owners	**Contractors**	**Architectural/Engineering**
1	Financing	Financing	Financing
2	Manpower	Material	Material
3	Changes	Contractual relationships	Contractual relationships

Table 4: Rank of Most Important Groups of Delay Factors[2]

[1] Ibid.
[2] Ibid.

2.3.4 Al-Khalil's Study

In a similar study that was conducted in 1997, sixty causes of delay were identified by Mr. Al-Khalil and Mr. Al-Ghafly.[1] Delay causes were compiled based on a review of literature, interviews and discussions with some government authority representatives, contractor engineers, consultant engineers working on water and sewage projects, and on personal experience pertaining to delay in public projects, since one of the authors had over 14 years of experience in such projects.

The sixty delay causes were summarized into six major categories. The category 'Contractor Performance" was further subdivided into five classifications. Table 5 (below) illustrates the major categories of delay.

No.	Category	Acronym
1	Contractor performance	**CP**
1.1	Materials	**CP**/MT
1.2	Equipment	**CP**/EQ
1.3	Manpower	**CP**/MP
1.4	Project management	**CP**/PM
1.5	Project finance	**CP**/PF
2	Owner administration	**OA**
3	Early planning and design	**P&D**
4	Government regulations	**GR**
5	Site and environmental conditions	**EC**
6	Site supervision	**SS**

Table 5: Major Categories of Delay in Al-Khalil's Study[2]

[1] Mohammed I. Al-khalil and Mohammed A. Al-ghafly, "Important Causes of Delay in Public Utility Projects in Saudi Arabia," *Construction Management and Economics* 17, no. 5 (1999).
[2] Ibid.

The study concluded that there is consensus among the three parties on the ranking of the frequency, severity, and importance of the causes of delay. On the contrary, the analysis showed lack of agreement among the parties on the ranking of the major categories of delay. Nonetheless, the agreement of the three parties on the importance of individual causes of delays was represented by a consensus ranking which was calculated by summing the ranks of the three parties for each of the delay causes, and ranking the resulting sums.

Among the most important causes found are cash flow problems and financial difficulties by the contractor, difficulties in obtaining work permits from authorities, and the requirements to select the lowest bidder without regard to prequalification.

The contractors considered the owner's administration as the most important category of delay, while the owners considered early planning and design as the most important category of delay. On the other hand, the consultants ranked contractors' performance as the most important category of delay. The ten most important causes of delay as seen by the consultants were all related to the contractor's work.

Table 6 (below) highlights the ten most important causes of delay as seen by each of the three parties and by the consensus ranking.

The authors believed that the findings of their research may also be applicable to projects of similar nature such as underground electrical and telephone projects.

Rank	Delay factor	Ranking by			
		Consensus	Contractor	Consultant	Owner
1	Cash flow problems faced by the contractor	**1.0**	5.0	1.0	1.0
2	Difficulties in financing the project by the contractor	**2.0**	13.0	2.0	3.0
3	Difficulties in obtaining work permits	**3.0**	2.0	15.0	2.0
4	Gov. tendering system requirement of selecting the lowest bidder.	**4.0**	8.0	5.5	9.0
5	Delay in progress payments by the owner	**5.0**	1.0	13.5	14.0
6	Effects of subsurface condition (type of soil, utility lines, water table)	**6.0**	4.0	11.0	18.0
7	Delay in mobilization	**7.0**	32.0	5.5	6.0
8	Change in the scope of the project	**8.0**	11.0	20.0	15.0
9	Ineffective planning and scheduling of the project by the contractor	**9.0**	38.0	7.0	4.0
10	Shortage of manpower (skilled, semi-skilled, unskilled labor)	**10.0**	30.5	13.5	7.0
11	Contractor's poor coordination with the parties involved in the project	**11.5**	33.0	9.0	11.0
12	Improper technical study by the contractor during the bidding stage	**11.5**	44.0	4.0	5.0
13	Excessive bureaucracy in the owner's administration	**13.0**	6.0	33.0	16.5
14	Ineffective control of the project progress by the contractor	**15.0**	46.0	8.0	10.0
15	Delay in the preparation of contractor submissions	**16.0**	52.0	3.0	12.0
16	Delay in the settlement of contractor claims by the owner	**18.0**	3.0	27.5	42.5
17	Ineffective delay penalty	**23.0**	34.0	39.0	8.0
18	Slow decision making by the owner	**25.0**	10.0	30.0	42.5
19	Poor qualification of the contractor's technical staff assigned to the project	**34.0**	54.0	10.0	30.0
20	Owner's failure to coordinate with Government authorities during planning	**34.0**	7.0	54.0	33.0
21	Owner's poor communication with the construction parties and Government authorities	**36.0**	9.0	50.0	41.0

Table 6: Important Causes of Delay in Public Utility Projects in Al-Khalil's Study[1]

[1] Ibid.

2.3.5 Al-Salman's Study

In 2004, Eng. ALSalman conducted a survey in order to investigate risks management perception and practice of construction contractors in Saudi Arabia. The study focused on risk allocation (both contractors' perception and as practiced); risk importance and risk effects on a construction project; and compares contractors' perception of allocating construction risks to the common practice of allocating these risks.[1]

Twenty five risk categories, that have either direct or indirect effect on the project budget, schedule, safety and quality, were selected to compose the survey questionnaire. Responses from 28 construction contractors of grade one and higher, as per the classification of the Chamber of Commerce, Eastern Province Chapter, were received and analyzed. Effects of each risk category on each parameter of the project were assigned if it weighs more than 25%, since four choices were given to participants to select from (budget, schedule, safety and quality).

The study concluded that the perception of construction contractors in Saudi Arabia in allocating surveyed risks is different from the common practice of allocating these risks. In practice, most of the risks are allocated to contractors and none to owners. Quality of work was found to be the most important risk while adverse weather condition is the least important risk. The surveyed risks had the highest impact on the schedule of a project.

Table 7 (below) lists the highly ranked risk categories as revealed by ALSalman's survey.

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[1] Ali Abdullah Al-Salman, "Assessment of Risk Management Perceptions and Practices of Construction Contractors in Saudi Arabia" (M.S., King Fahd University of Petroleum and Minerals (Saudi Arabia), 2004).

Rank	Weighted Importance	Risk Category	Risk Effects on a Project
1	140	Quality of work	Quality, budget
2.5	134	Delayed payment on contract	Budget, schedule
2.5	134	Financial failure	Budget, schedule
4.5	128	Scope limitation & work definition	Budget, schedule
4.5	128	Labor, material & Equip, availability	Schedule, budget
7.5	121	Safety/ Accidents	Safety
7.5	121	Contractor competence	Budget, schedule & quality
7.5	121	Change order negotiations	Budget, schedule
7.5	121	Accuracy of project program	Schedule, budget
10.5	115	Site access	Schedule, safety
10.5	115	Defective materials	Undecided

Table 7: Risk Categories as Ranked by Saudi Construction Contractors in 2004[1]

2.3.6 Arain's Study

In 2004 Arain, Pheng, and Assaf identified, from literature review, 45 potential causes that may lead to inconsistencies between the design and construction parties.[2] A survey of 42 main contractors, who were executing large building projects (US$5.3 million or more) in the Eastern Province of Saudi Arabia, was conducted to identify and assess how contractors view the potential causes of inconsistencies at the design and construction interface. It is worth mentioning that the study excluded contractors who were involved in the construction of industrial buildings, highways, and other types of construction. The author of this report classified nine of the identified forty-five potential causes as external causes. These external risks are: Lack of Designer's Knowledge of Available Materials and Equipment, Material Approval (Pre-qualification), Lack of Skilled Manpower, Involvement of Designer as Consultant, familiarity with the country's Building

[1] Ibid.
[2] Faisal Manzoor Arain et al., "Contractors' Views of the Potential Causes of Inconsistencies between Design and Construction in Saudi Arabia," *Journal of Performance of Constructed Facilities* 20, no. 1 (2006).

Codes, Government Regulations, Economic Situation, Nationalities of Participants, and Weather Conditions.

Arain's study concluded that the involvement of designer as consultant, communication gap between constructor and designer, insufficient working drawing details, lack of coordination between parties, lack of human resources in design firm, lack of designer's knowledge of available materials and equipment, and incomplete plans and specifications were considered to be the most important causes of inconsistencies at the project design and construction interface. None of the identified important causes was an external risk except for the 'lack of designer's knowledge of available materials and equipment' risk.

2.3.7 Al-kharashi's Study

A study conducted by ALKharashi and Skitmore, in 2008, employed the results of 10 previous studies that have identified the causes of delay of construction projects in Saudi Arabia.[1] Together, these 10 studies produced 112 causes of delay.[2] [3] These causes were then investigated further by means of a questionnaire survey in order to identify the causes of delays that produce the greatest effects and the extent to which these effects can be improved in the Saudi Arabian construction industry. Responses on a five-point scale, comprising 0='No effect' to 4='Lot of effect', were received from 34 contractors, 31 consultants, and 21 clients working in Saudi Arabia.

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[1] Adel Al-kharashi et al., "Causes of Delays in Saudi Arabian Public Sector Construction Projects," *Construction Management and Economics* 27, no. 1 (2009).
[2] These ten studies are: Al-Mudlej, 1984; Al-Hazmi, 1987; Al-Ojaimi, 1989; Al-Ghafly, 1995; Assaf and Mohammed, 1995; Al-Khalil and Al-Ghafly, 1999; Odeh and Battaineh, 2002; Arain et al., 2006; Assaf and Al-Hejji, 2006.
[3] All of these ten studies are included in the bibliography of this report except (Al-Mudlej's Master Degree Thesis: Causes of delays and overruns of construction projects in Saudi Arabia, 1984)

Most respondents were involved in projects costing over US$20 million. An open-ended qualitative question was also added to evaluate the cost to improve practices in a way that will eliminate a cause. In addition to the 112 causes documented in the questionnaire, 19 new delay causes were nominated by some respondents. All 131 delay causes identified in this ALKharashi's study are listed in **Appendix-B** in this report. Table 8, Table 9, and Table 10 (below) lists the 10 causes of delays in Saudi Arabian public sector construction projects that produce the greatest effects as seen by the three parties in 2008.

R	Category	Causes of Delay as Seen by Contractors in 2008	Avg
1	Client Related	Suspension of work by the owner	**3.61**
2	Labor Related	Shortage of manpower (skilled, semi-skilled, unskilled)	**3.6**
3	Materials Related	Shortage of construction materials in market	**3.6**
4	Consultant Related	Delay in approving major changes in the scope of work by consultant	**3.6**
5	Client Related	Non-payment of contractor claim	**3.58**
6	Client Related	Lack of finance to complete the work by the client	**3.55**
7	Contractor Related	Contractor experience	**3.5**
8	Contractor Related	Difficulties in financing project by contractor	**3.5**
9	Contractor Related	Poor site management and supervision by contractor	**3.47**
10	Client Related	Late in revising and approving design documents	**3.47**

Table 8: Top Causes of Delays in Saudi Public Construction Projects as Seen by Contractors[1]

[1] Al-kharashi et al., "Causes of Delays in Saudi Arabian Public Sector Construction Projects."

R	Category	Causes of Delay as Seen by Clients in 2008	Avg
1	Labour Related	Shortage of manpower (skilled, semi-skilled, unskilled)	3.6
2	Contractor Related	Contractor experience	3.57
3	Labour Related	Poor qualification of the contractor's technical staff assigned to the project	3.5
4	Contractor Related	Ineffective scheduling of project by contractor	3.45
5	Contractor Related	Delay in the preparation of contractor submissions	3.41
6	Materials Related	Shortage of construction materials in market	3.4
7	Materials Related	Shortage of materials required	3.4
8	Contractor Related	Improper technical study by the contractor during the bidding stage	3.38
9	Contractor Related	Poor qualification of the contractor's technical staff	3.33
10	Materials Related	Late procurement of materials	3.3

Table 9: Top Causes of Delays in Saudi Public Construction Projects as Seen by Clients[1]

R	Category	Causes of Delay as Seen by Consultants in 2008	Avg
1	Contractor Related	Poor qualification of the contractor's technical staff	3.87
2	Contractor Related	Poor site management and supervision by contractor	3.78
3	Contractor Related	Contractor experience	3.7
4	Labour Related	Shortage of manpower (skilled, semi-skilled, unskilled)	3.7
5	Contractor Related	Difficulties in financing project by contractor	3.65
6	Materials Related	Shortage of materials required	3.6
7	Labour Related	Shortage of technical professionals in the contractor's organization	3.6
8	Labour Related	Poor qualification of the contractor's technical staff assigned to the project	3.6
9	Client Related	Delay in progress payments by the owner	3.59
10	Contractor Related	Ineffective control of the project progress by the contractor	3.57

Table 10: Top Causes of Delays in Saudi Public Construction Projects as Seen by Consultants[2]

[1] Ibid.
[2] Ibid.

ALKharashi concluded that the results are confounded to some extent by significant differences of the three parties' opinions, particularly between the contractors and consultants – each tending to blame the other to some extent. Regardless, the dominant view of the cause of construction delay concerns *the shortage of qualified and experienced manpower*, most likely brought about by the boom in construction activities at the time of the study, i.e. mid 2000s.

2.3.8 The Korean Study

A study that was conducted by South Korean researchers in 2011, suggested a country portfolio optimization model for managing country portfolios during a fluctuating global construction market.[1] The model presents the quantitative diversification strategy that optimizes country portfolio solutions through considering four critical objectives at the country level: (1) market growth rate, (2) market growth volatility, (3) market profit rate, and (4) market profit uncertainty. The study examined **1,014 international projects** executed over the past decade by Korean contractors across 21 countries, including Saudi Arabia. The examination revealed that the Saudi construction market is a stable and relatively attractive market. The study classified the Saudi market as high-growth market with low growth volatility. However, the Saudi market was considered, based on the Korean contractors' experiences, low profit rate market with a relatively high profit uncertainty. Regardless, the researchers advised their readers to target the Saudi construction market if they want to increase market growth and restrict market growth volatility in their portfolio.

[1] Wooyong Jung et al., "Country Portfolio Solutions for Global Market Uncertainties," *Journal of Management in Engineering* 28, no. 4 (2012).

2.3.9 The Malaysian Study

Mr. Siaw Loo published a paper in 2013 that aimed to analyze the risks that foreign architectural, engineering, and construction (AEC) firms faced when undertaking projects in the Gulf Cooperation Council (GCC)[1] states and to determine the risk response measures taken by these firms.[2]

Through a questionnaire survey and case studies among architectural, engineering, and construction (AEC) firms operating in the Gulf, this study found 19 (36.5%) external risk factors that should be contemplated before the award of contracts and 28 (53.9%) afterward to ensure smooth running. Another 5 (9.6%) external risk factors were found to be not applicable to the Malaysian AEC firms involved in Gulf construction or not encountered by them. Also, an external risk breakdown structure (E-RBS) and a framework for foreign AEC firms operating in Gulf Cooperation Council (GCC) states were developed for users to identify and respond to external risks in a more systematic manner. The framework included measures that can be taken to mitigate and manage these external risks.

However, Loo's paper had some major limitations that limits its contribution to this research. Firstly, risks identification step was completed by building a generic External Risk Breakdown Structure (E-RBSS) based on literature review that included risk studies from all over the world, including China. Instead, the researchers should've reviewed literature that identified causes of failure in the GCC states' projects. Secondly, the scope of the study was confined to Malaysia-based firms that undertook projects in the

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[1] The Gulf Cooperation Council (GCC) consists of Saudi Arabia, the United Arab Emirates, Kuwait, Bahrain, Qatar, and Oman.

[2] Chuing Loo et al., "Managing External Risks for International Architectural, Engineering, and Construction (Aec) Firms Operating in Gulf Cooperation Council (Gcc) States."

GCC region. Thirdly, only 4.2% of the surveyed projects sample were infrastructure projects. Finally, the case studies included in the study had only one infrastructure project that was being executed in Dubai, UAE. Saudi projects that were part of the case studies were educational, city development, and commercial related projects.

Table 11 (below) list the ten risk factors with the highest ranking. Also, Table 12 (below) lists six positive risk factors (opportunities) as well as their corresponding suggested responses, with no specific order.

R	External Risk	R	External Risk
1	Compliance with written contract	**6**	Laws and regulations
2	Ease of settling disputes	**7**	Constraints on employment of expatriates
3	Economic recessions	**8**	Cultural differences
4	Delay in approval or permit requirements	**9**	Other influential economic events
5	Material, equipment, and manpower price fluctuation	**10**	Need detailed procedures

Table 11: Top Ten External Risks in GCC as Ranked by Malaysian AEC Firms[1]

[1] Ibid.

No	Risk Factor	Risk Response Measure
1	Fiscal policies	Accelerate economic diversification and development of the non-oil sectors such as tourism and residential and commercial real estate
2	Government control	Abundant assistance from the government or local authority in ensuring the success of government projects
3	Use of local firms and agents	Support in legally obtaining manpower and agent
4	Other influential economic events	GCC governments' spending policies encourage foreign firms' investments
5	Import or export restrictions	To accelerate the construction growth of the GCC states, an 'open market' was their government policy. There are no customs and import restrictions imposed on trading.
6	Customs and import restrictions	To accelerate the construction growth of the GCC states, an 'open market' was their government policy. There are no customs and import restrictions imposed on trading.

Table 12: Opportunities Identified by Malaysian AEC Firms Working in GCC States[1]

It is worth mentioning that the Loo's paper addressed a specific and important threat in the Saudi Construction Industry. The following is a quote from the Paper: "An example of government control was given by C1 which the government of Saudi Arabia imposed on all foreign companies *the requirement that 30% of their workers must be Saudis. Saudization was the expression given by C1*. Unfortunately, the salary of a Saudi was much higher than that of a Malaysian, hence causing expensive operation costs and incorporating the extra costs in the projected tender price."[2]

[1] Ibid.
[2] Ibid., 83.

2.4 Findings and Summary

Many external risks in the Saudi Construction Projects, whether threats or opportunities, were identified in the past 20 years. Some of these risks persist regardless of the time period in which a Saudi construction project was executed. For example, availability of qualified manpower and skilled labor, caused by working visa restriction, and excessive bureaucracy are reoccurring threats that were captured in many of the reviewed studies.

Other threats were time dependent and existed during certain periods of time such as economic recession (National Slump in the Economy) in the 1990s and economic boom in the 2000s. In the matter of fact, the economic conditions in the GCC countries were considered as an opportunity in latter studies (2011 & 2013).[1] [2]

2.4.1 Identified Threats

Table 13 (below) lists the highly ranked external threats identified in Saudi Construction Projects in the past 20 years. The list is arranged according to the time at which these risks were identified.

[1] Jung et al., "Country Portfolio Solutions for Global Market Uncertainties."
[2] Chuing Loo et al., "Managing External Risks for International Architectural, Engineering, and Construction (Aec) Firms Operating in Gulf Cooperation Council (Gcc) States."

Y	Threats	Y	Threats
1993	– Lack of experience in the line of the work – Construction Industry Regulation in Saudi Arabia. Systematic items and descriptions were not available – Lack of standard of measurement. – The availability of the local subcontractors – Long warranty period	2006	– Lack of Designer's Knowledge of Available Materials and Equipment, – Long Material Approval Process (Pre-qualification), – Lack of Skilled Manpower – Government Regulations
1995	– Excessive bureaucracy in project-owner operation – Manpower shortage and labor skills – Delay in the special manufacture out of KSA – Slowness of owner's decision-making process – Waiting for sample materials approval	2009	– Shortage of manpower (skilled, semi-skilled, unskilled) [due to the visa issuance regulations] – Shortage of construction materials in the Saudi Market – Delay in progress payments by the owner – Non-payment of contractor claim
1997	– Difficulties in obtaining work permits – Government tendering system requirement of selecting the lowest bidder. – Delay in progress payments by the owner – Shortage of manpower (skilled, semi-skilled, unskilled labor) – Excessive bureaucracy in the owner's administration – Delay in the settlement of contractor claims by the owner – Slow decision making by the owner	2011	– Saudi Construction Market has a low profit rate – Saudi Construction Market has a relatively high profit uncertainty
2004	– Delayed payment on contract – Labor, material and Equipment availability – Change order negotiations – Site access	2013	– Hardship of settling disputes – Delay in approval or permit requirements – Material, equipment, and manpower price fluctuation – Laws and regulations e.g. Saudization – Constraints on employment of expatriates

Table 13: Highly Ranked External Threats Identified in Saudi Construction Projects in the Past 20 Years

Source: Summary of all citied studies in the literature review chapter

2.4.2 Identified Opportunities

All identified risks in the reviewed studies that had a low risk score can be considered as positive attributes of the Saudi Construction Industry. Because these risks were

identified, evaluated, ranked, and found to have low Expected Monetary Values (EMV), i.e. low importance. This is either because of their low probability (P) of occurrence or because of their limited potential impact (I).

$$EMV = P \times I$$ [1]

Nonetheless, exact opportunities were mentioned in some of the reviewed studies. The first opportunity is the financial nature of the Saudi construction market. It was classified by the main Korean Contractors as a high-growth market with low growth volatility. In addition, the Malaysian Contractors identified the following three opportunities in Construction Projects in the GCC countries:

1. Abundant assistance from the government
2. Available support from local firms and agents
3. Open Market Policy with no import restrictions imposed on trading

At the end of the literature review, the author had a question in mind that could be a subject for further research. The question is: “whether there is a direct correlation between the current level of development in a country and the type of threats in its major construction projects?” For example, would bureaucracy be highly ranked as a threat in a construction project that is being executed in an underdeveloped country? Another example is the availability of skilled manpower in a developed country.

Finally, all 131 delay causes identified in ALKharashi’s study are listed in **Appendix-B**.

[1] Project Management Institute., *A Guide to the Project Management Body of Knowledge (Pmbok Guide)*, 338.

CHAPTER 3 - RESEARCH PROCEDURE

The Research Procedure Chapter answers the following questions:

- How was the research completed?
- What were the methods used for the primary research, and how it was selected?
- What are the methods' advantages and disadvantages?
- How were the research methods (expert interview) designed and conducted?
- How were the subjects (interviewees) selected?
- What were the outcomes of the primary research?

3.1 Research Methodology

The research methodology included the following essential six steps;

Step one: Defining project risks management, risks identification process and SEC Power Generation Projects.

Step two: Comprehensively reviewing written literature of the available work reported on project risk management, project risks identification process, risks in Saudi Arabian Power Generation Projects, and risks in Saudi Arabian construction industry. The review includes the recent literature on the subject that includes the past twenty years.

Step three: Design of an expert interview related to the identification of risks in Saudi Power Generation Projects and specifying the effects of these risks on the projects.

Step four. Data was collected, compiled and analyzed.

Step five: Results from the analyzed data were summarized and presented.

Step six: Conclusion of the research, recommendations, and suggestions for further work were introduced.

3.2 Primary Research Method

3.2.1 Expert Interview

Expert Interview, which is an example of the Qualitative Research Interview (QRI) was selected as the main primary research method. There are three main reasons for selecting this method. First. The interview method is a recognized mean of gathering information for primary research. Second, Expert interview method is a recognized risk identification technique. Third, the nature of this research and the construction industry limits the primary research options to mainly direct interviews and questionnaires.

Also, the expert interview method was selected because of the fact that substantially more risks can be identified if risk identification is done fact-to-face. Much better understanding of the identified risks can be obtained because of the option to observe body language and facial expressions.[1]

However, when an experts interview is conducted to identify project risks, it should include all main stakeholders and be conducted by an independent skilled interviewer using a structured agenda, in an atmosphere of confidentiality, honesty, and mutual trust.

3.2.2 Prompt Lists

The *PMI Practice Standard for Project Risk Management* recommends the use of a checklist or prompt list as a framework for risk interviews.[2]. A prompt list is a set of risk categories which can be used to customize a list of risk categories that are most relevant

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[1] Mulcahy and Mulcahy, *Rita Mulcahy's Risk Management Tricks of the Trade for Project Managers : And Pmi-Rmp Exam Prep Guide : A Course in a Book*, 72.
[2] Project Management Institute., *Practice Standard for Project Risk Management*, 81., 2009

to a project. When used properly, a prompt list of risk categories can be extremely beneficial in risk identification. A generic list of risk categories includes:[1]

- Technical, quality, or performance
- Project management risks
- Organizational risks
- External risks.

The prompt list may be presented as a risk breakdown structure, or a set of headings. A number of standard prompt lists have been developed for use in risk identification, and some of these are presented below. These can then be used as a framework for other risk identification techniques such as brainstorming or risk interviews.[2]

The PESTLE prompt list:

- Political
- Economic
- Social
- Technological
- Legal
- Environmental

The TECOP prompt list:

- Technical
- Environmental
- Commercial
- Operational
- Political

The SPECTRUM prompt list:

- Socio-cultural
- Political
- Economic
- Competitive
- Technology
- Regulatory/legal
- Uncertainty/risk
- Market

3.2.3 Interviewing Technique: Advantages and Disadvantages

Table 14 (below) summaries the advantages and disadvantages of the selected research methods.

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[1] Mulcahy and Mulcahy, *Risk Management Tricks of the Trade for Project Managers : And Pmi-Rmp Exam Prep Guide*, 89.
[2] Project Management Institute., *Practice Standard for Project Risk Management*, 82.

Method	Overall Purpose	Advantages	Challenges
Interviews (QRI)	Used to fully understand someone's impressions or experiences, or learn more about their answers to questionnaires	– get full range and depth of information – develops relationship with client – can be flexible with client	– can take a lot of time – can be hard to analyze and compare – can be costly – interviewer can bias client's responses
Expert Interviews	Used to gain expert opinion	– Addresses risks in detail – Generates engagement of stakeholders	– Needs careful planning – Time consuming – Raises non-risks, concerns, issues, worries, etc. – Requires filtering
Prompt Lists	Used to customize a list of risk categories that are most relevant to a project	– Ensure coverage of all types of risk – Stimulates creativity	– Topics can be too high level

Table 14: Advantages and Disadvantages of the Selected Research Methods [1] [2]

3.3 Interview Design and Procedure

3.3.1 Expert Interview Design

An appropriate prompt list, that serves the purpose of the research, was selected. Since the focus of this research is to identify external risks in Saudi Power Generation projects, the following prompt list was selected:

- Legal risks
- Social risks
- Economic risks
- Environmental risks
- Technical risks

[1] Robert S Weiss, *Learning from Strangers: The Art and Method of Qualitative Interview Studies* (Simon and Schuster, 1995), 9-11.
[2] Project Management Institute., *Practice Standard for Project Risk Management*, 74.

Although the last item of the list, Technical risks is generally considered as internal risk category, it was still included in the list. The reason for that is the fact that some technical risks are generated from environmental circumstances. For example, the high atmospheric temperature can cause technical challenges to the designers of main equipment. To direct the attention of the interviewee towards technical risks, caused by the fact that the power generation project is being executed in Saudi Arabia, an open ended question had to be drafted very carefully.

Based on the above prompt list, specific open ended questions were prepared. They are:

1. What are the *legal risks, caused by the Saudi legal system,* which could affect a Saudi Generation Project?
2. What are the *Social risks, caused by the Saudi Society*, which could affect a Saudi Generation Project?
3. What are the *Economic risks, caused by the Saudi Economic conditions,* which could affect a Saudi Generation Project?
4. What are the *Environmental risks, caused by the Saudi nature and location as well as Saudi environmental regulations*, which could affect a Saudi Generation Project?
5. What are the *Technical risks, caused by the Saudi circumstances,* that could affect a Saudi Generation Project?

Finally, a well thought of introduction was prepared for the Expert Interview. Its purpose was to explain the intent of the interview and to prompt the interviewee to give specific, experience-based responses. Appendix-C contains a copy of the Expert Interview Introduction.

3.3.2 Expert Interview Procedure

The following steps were implemented during the expert interview. They represent the sequence of the Expert Interview:[1]

1. Thanking the interviewee for accepting the interview request
2. Explaining the purpose of the interview
3. Asking an open ended question
4. Asking more question to clarify the Response(s) to the open ended question
5. Following up with previously prepared and specific questions
6. Clarifying responses
7. Asking for other ideas
8. Exchanging contacts details to encourage sending new ideas
9. Thanking the interviewee for his time

Mainly, the interview had three parts. The first part is an introduction to explain the purpose of the interview in order to receive risk related answers. The second part contained a background information sheet that elicit the interviewee's level of education and experience in power generation projects. The third part has five open ended questions about the external risks in Saudi Power Generation Projects.

3.4 Interviewees Selection Criteria

The following are the criteria that were implemented in selecting the interviewee i.e. expert:

1. Has more than 15 years of total experience since earning a bachelor Degree.
2. Has more than 5 years of experience in a managerial role in Mega projects.

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[1] Mulcahy and Mulcahy, *Risk Management Tricks of the Trade for Project Managers : And Pmi-Rmp Exam Prep Guide*, 97-100.

3. Participated in more than three different countries (exception: interviewees from the client/SEC side)
4. Currently involved in engineering, executing or controlling a Saudi Power Generation Project or involved in preparing a bid proposal for one.

In order to get the input from local experts who represents the client, i.e. SEC (the buyer), the third condition was waived in one case only. A form was designed and shared with each interviewee to collect his background information. A copy of this form is included in Appendix-C of this report.

3.5 Primary Research Outcomes

Ten (10) interviews were conducted with world class experts. Only two of these interviews were with the client's representatives i.e. the buyer (SEC). The rest of them were with sellers. Three of the sellers represented well-known engineering consultancy firms which were completing the engineering scope for EPC Contractors. The other five sellers represented international EPC contractors.

Table 15 (below) lists the names, positions, and roles of the ten interviewed experts. It also shows the names of their companies and the nationalities of their companies.

Responses from the ten interviews were noted down and analyzed. For example, experts' bias was taken into account during data analysis (a buyer or a seller). Then, cross-comparison of the answers received for each interview question was completed in order to draw conclusions as to how similar the answers were, and to rank the identified risks. Finally, a general comparison between the risks, identified during the experts' interviews, and those identified from the literature review was completed.

No	Interviewee	Position	Company	Company's Nationality	Role
1	Abdulrahim AlShaikh	Senior Project Manager	SEC	Saudi	Client
2	Crikumar Srikumar	Senior Project Manager	SEC	Saudi	Client
3	John Hughes B&V	Senior Project Manager	Black & Veatch	American	Consultant
4	Mike Kuczynski	Engineering Manager	Sargent & Lundy	American	Consultant
5	Conor O'Neill	Project Director	WorleyParsons	American / Australian	Consultant
6	Rafel Zaballa	Proposal Manager	Initec Energia	Spaniard	Contractor
7	Felipe Morales	Project Director	Tecnicas Reunidas	Spaniard	Contractor
8	Alejandro Alemán	Head of Proposal Dept.	Duro Felguera	Spaniard	Contractor
9	Carlos Hidalgo	Proposal Manager	Abeinsa Abdngoa / Abengoa	Spaniard	Contractor
10	Won Tae Chung	VP, EPC Proposal	Doosan	Korean	Contractor
	Young Dook Kim	EPC Senior Project Manager			

Table 15: Names, Positions, and Roles of The Ten Interviewed Experts

CHAPTER 4 - RESULTS

The Results Chapter reviews the outcomes of the primary research, classifies the interviewed experts, categorizes the identified risks, and explain the risk ranking method. Also, all identified threats will be described, and ranked in the result chapter. In addition, major opportunities that were identified during the interviews will be shared. Finally, the Results Chapter will conclude with a summary section emphasizing the major findings of the research and highlights the highly ranked threats, and compares them with the threats identified during the literature review.

4.1 Experts Classification

Ten (10) experts' interviews were completed. Two of these interviews were with the client's representatives (CL), three were with engineering consultancy firms' representatives (CS), and the rest five interviews were with EPC contractors' representatives (CR). Needless to say that there is one major client in Saudi Arabia for Power Generation projects that is the sole electrical utility company, Saudi Electricity Company (SEC).

The above classification was made to take into account the experts' bias, if existed (a buyer or a seller). At the same time, it will allow for keeping the anonymity of a specific response's provider.

Also, expert's classification will help in ranking the identified risks. For example, a risk that was identified by one client representative and one contractors' representatives is higher in ranking than a risk that was identified only by two contractors' representatives.

Although the two risk will have a ranking score of two (2), the former will be ranked higher because it was identified by both the buyer and the seller.

4.2 Risks Categorization

Based on the selected prompt list as well as the interview questions listed in Section 3.3.1 in this report, the identified risks, whether threats or opportunities, were divided into five categories:

- Legal risks
- Social risks
- Economic risks
- Environmental risks
- Technical risks

4.2 Identified Threats

Since only highly ranked threats that scored three or higher will be described in details, the ranking mechanism has to be explained first. All provided descriptions were based on the responses received from the interviewed experts. Other threats that had a low ranking score will be briefly explained. A table that lists all identified threats and their ranking will be presented.

4.2.1 Threats Ranking

Risk ranking is usually done by estimating the probability of the risk occurring as well as estimating the impact on the project if the risk was to occur (EMV = P x I). Since the purpose of this research is just to identify external risks in a Saudi Power Generation project, the ranking mechanism will be based on how many time a specific risk was identified in the ten interviews.

101 responses were elicited during the ten interviews. 27 threats were identified by collecting 88 responses. 17 of them were major threats that has a score equal or higher than three. In other words, 17 of these threats were identified in at least three interviews. The 17 major threats were identified from collecting 71 responses. The rest of the responses (17) were related to minor threats that had a score of one or two. Table 16 (below) lists all identified threats, their ranking and categorization.

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No	Category	Threat	Rank	CL	CS	CR
01	6 Legal Threats (26 Responses)	**Working Visas**	**7**	2	1	4
02		SEC Contract's General Terms and Conditions	**6**	0	1	5
03		Change of Laws and Regulations	**4**	1	0	3
04		Customs Clearness	**3**	2	0	1
05		**Saudisation Requirements**	**3**	1	0	2
06		Work permits from local authorities	**3**	1	0	2
07	5 Social Threats (17 Res.)	**Saudi Manpower**	**7**	1	2	4
08		Adaptation of Foreign Workers	**4**	1	0	3
09		Ramadan: The Fasting Month	**3**	1	0	2
10		Women Participation	**2**	0	0	2
11		Local Manufacturers' Working Style	**1**	0	0	1
12	5 Economic Threats (9 Res.)	Infrastructure	**3**	1	1	1
13		Prices inflation of local services & material	**2**	1	1	0
14		Economic Boom (availability of resources)	**2**	0	0	2
15		Currency Liquidity	**1**	0	0	1
16		High Competition	**1**	0	1	0
17	5 Environmental Threats (15 Res.)	Weather	**5**	1	0	4
18		Environmental Regulations	**4**	1	3	0
19		Polluted Working Sites	**2**	1	0	1
20		Power Plants Fuel	**2**	0	1	1
21		Availability of fresh water	**2**	0	0	2
22	6 Technical Threats (21 Responses)	**Local manpower**	**5**	2	1	2
23		Stringent Specs and Standards	**4**	0	2	2
24		Availability of technical data for new projects	**4**	0	1	3
25		Local Suppliers/Subcontractors	**3**	1	0	2
26		Technical Gaps in the Specs	**3**	0	0	3
27		Representation of International Suppliers	**2**	2	0	0

Table 16: Identified Threats Ranking and Categorization

4.2.2 Threats Descriptions

The following subsections provides detail descriptions of all identified threats that scored three or more. In other words, all threats that were mentioned by at least three experts in three different interviews will be explained in details. Brief description for minor threats will also be provided.

4.2.2.1 Legal Threats

26 responses identified six legal threats. All of them were highly ranked. These threats are:

Working Visas (Rank: 7)

Movement of workers to and from Saudi Arabia is very restricted for both workers and businessmen, because of the working visa regulations and process. It makes the mobilization of contractor' professionals and skilled workforce expensive and time consuming.

In addition, the Saudi visa quota system is a source of threat as well. The given number of workers must be divided into different countries. For example, if the contractor was given 500 workers visas, he must recruit them from different countries such as India, Philippines, and Pakistan. Some contractors have subsidiaries in their own countries that have well trained workers, but the quota system will not allow them to take advantage of their skilled manpower.

Add to that the fact that there are not enough skilled and semi-skilled foreigner construction workers in Saudi Arabia. The proportion of this risk has recently increased

because of the enforcement activities of the labor laws that were carried out at the end of 2013 and the restrictions on the availability of new visas.

By the end of 2013, work permits for non-Saudi became more stringent. These new regulations pose a threat that could affect the number of qualified non-Saudi manpower who can participate in a Saudi Generation Project.

General Terms and Conditions in SEC Contract (Rank: 6)

Major Saudi firms such as Sabic, Saudi Aramco, and SEC have their own standard contracts that are different from the International Federation of Consulting Engineers (FIDIC) standard contracts; this generate risks in the form of Unlimited Liability and Consequential Damages.

One of the sources of threats caused by the current general terms and conditions is the definition of “Force Majeure” in SEC contracts, General Terms and Conditions (Schedule A). Typically, Force Majeure events are a listing of defined events over which no party has control. Generally, an EPC contractor expects schedule relief and compensation for events beyond his control. EPC contractors and many Owners like to have the events considered as Force Majeure specifically listed in the contract which is not the case in SEC Power Generation Projects.

In addition, payment conditions, imposed by the client (SEC), could create a negative cash flow for the main contractor during a large portion of the project execution phase. Neutral cash flow should be the perfect case for all associated parties. Another possible risk is a financial exposure caused by suspending or terminating the project by the client during the execution stage, which is a period of negative cash flow in the project lifecycle.

On the other hand, and to ensure quality in the new Power Generation Plants, prospective suppliers and subcontractors for power generation projects has to be approved by SEC. SEC already has a list of approved vendors and subcontractors known as Approved Vendor List (AVL) and Approved Subcontractor List (ASL). As per the contract's General Terms and Conditions, these lists of qualified suppliers and subcontractors has to be followed by the EPC contractor. However, the lists don't cover all equipment categories and some categories have very few number of approved suppliers/subcontractors. Hence, the contractor needs to approve new suppliers/subcontractors; however, SEC pre-qualification process of new vendors and subcontractors is time consuming and could cause schedule delays. Another cause that could trigger this threat is the possibility that approved suppliers/subcontractors are overloaded and can't participate in a new project.

Moreover, manufacturing base is moving from the Western World, mainly the US and Western Europe, to the Eastern World, mainly China and India. Nonetheless, SEC insists on focusing their prequalification effort on the Western manufacturers.

Another threat is the fact that the current Client's tendering policy don't allow for commercial deviations during the bidding process. These deviations are seen by some contractors as a good maneuver around a known threat. The following is a quotation from the "Instructions to Bidders - Commercial Proposal, (Two Envelopes)" document which is part of SEC Standard Bid Documents for a two Envelope Lump Sum Turn Key power generation project tender:

> Only bidders who's First Stage Bid (Technical Proposal) is found acceptable will be invited to submit a Second Stage Bid (Commercial Proposal). **The Second Stage Bid (Commercial**

Proposal) will be submitted *WITHOUT* any commercial deviation, on the date, time and place indicated in the Invitation for submission of Second Stage Bid (Commercial Proposal). Any deviation included in the Commercial Proposal will not be accepted.

Finally, instead of International Laws, local laws are enforced in SEC contracts. Hence, to some consultants and EPC contractors the Saudi legal system can be unfamiliar. They can't be certain of possible outcomes of a legal suit or dispute.

Change of Laws and Regulations (Rank: 4)

Sudden changes in regulatory requirements is a major threat. For example, engineering consultancy firms and EPC contractors have to comply with the new regulations issued by High Commission for Industrial Security (HCIS). The HCIS was inaugurated in 2010. Another example, is a resent amendment to the Saudi Labor Law that took effect on 15th Nov. 2012. It requires all companies to pay an annual fee of SR 2,400 for each non-Saudi worker, if the percentage of the Saudi employees in a particular company is less than 50% of the total workforce. [1]

An example that is more applicable to engineering consultancy firms is the fact that the Saudi regulatory system requires forgone consultants to have a local engineering partner to be able to participate in Public Projects.

Customs Clearness (Rank: 3)

Saudi Customs' regulations are not business friendly, as described by one of the experts. Importing, releasing, and exporting equipment and materials can be "a

[1] Justin Harper, 2012. "Saudi Arabia to Fine Firms That Employ Too Many Expats," *The Telegraph*, http://www.telegraph.co.uk/finance/personalfinance/expat-money/9681523/Saudi-Arabia-to-fine-firms-that-employ-too-many-expats.html (accessed November 16, 2014).

nightmare.” Regulations for chemical materials and gases are the most stringent. An example of exporting material is damaged materials that has to be sent back to the supplier or to an out-of-Kingdom workshop for repairs. It needs many paper work and long processing time. Also, the delay will double, if not triple, in the month of Ramadan.

In addition, the newly added regulations by the Saudi government requires more documentation such as invoices and purchase orders (POs). The list of shipped equipment or material, coming with shipment package, and the list coming from the EPC contractors, who is executing a project inside the country, must be identical. However, the supplier may have different names for his equipment than the ones provided by the EPC contractor in the PO which could cause delays. In general, delay of customs clearance is a major threat. This is why free on board (FOB) delivery method has a high risk. The right response to this threat, as suggested by one of the experts, is to hire an excellent local custom clearance brokerage firm and to transfer as much of it to the contractor by adding the task of delivering the equipment to the site to the contract scope.

In addition, some of the employees at the Saudi Customs responsible for opening and inspecting goods are not aware of the delicate nature of some of the materials being transported to Saudi Arabia and thus do not take the necessary due care when opening these packages. This provides a high risk of damaging the contents that have been carefully packaged inside, thus delaying their delivery to project site.

Saudization Requirements (Rank: 3)

The 'Saudization' term refers to the official national policy of Saudi Arabia that aims to replace foreign workers with Saudi nationals in the private sector.[1] The policy mandates that a certain percentage of Saudi employees must be maintained by each company. However, the minimum required percentage differ from one sector to another. Saudization requirements was recently changed and became more stringent. For example, the lowest accepted Saudization level in the commercial establishments and insurance companies is 19 percent.[2] Unfortunately, the current availability of skilled Saudi manpower makes it difficult to achieve the required percentages.

Work permits from local authorities (Rank: 3)

Governmental administrative processes take long time in Saudi Arabia which could bring some delay to the project. For example, working permits needed from local authorities to execute the work at site can be sources of schedule risk. One response to these legal risks is to form a partnership with an approved local contractor and form a locally registered Joint Venture.

A more specific example, is acquiring the required approvals to complete any construction work at the coast line that goes into the sea. A Committee of six different government agencies has to give that approval. The structure of water intake in a Thermal or Combined Cycle Power Generation project requires such approval from this Committee.

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[1] Adel S. Al-Dosary and Syed Masiur Rahman, "Saudization (Localization) – a Critical Review," *Human Resource Development International* 8, no. 4 (2005).
[2] "New 'Fairer' Saudization Rules Come into Force," *McClatchy - Tribune business news*. , http://search.proquest.com/docview/1657456526?accountid=14556.

4.2.2.2 Social Threats

17 responses identified five social threats. Three of them were highly ranked. The identified social threats are:

Saudi Manpower (Rank: 7)

As described by many interviewed experts, a major social threat is finding skilled, competent, and qualified local manpower, who are motivated to work in projects located in remote areas. Many stated that there are not enough qualified and skilled Saudi manpower. Although the numbers of Saudis, who are participating in generation projects are increasing, they still don't have the needed experience.

When the Saudization requirements are added to the above observation, this threat becomes a compounded and complex one. All EPC contractors, who are planning to participate in a Saudi Generation Project, have to prepare themselves ahead of time to deal with this alarming threat.

Adaptation of Foreign Workers (Rank: 4)

Saudi Culture and traditions are very unique. This fact can be a source of perils such as misunderstandings and legal issues. One may ask: how would the consultants' and contractors' expatriates adopt to the local social conditions? They may need long time to adopt. Other examples of this social threat are:

- finding local educational institutes for their children,
- disturbing the local customs of the local people
- underestimating the consequences of some of their behavers
- causing conflict because of the cultural differences

Also, highly skilled and qualified westerns professionals find living conditions in Saudi Arabia very tough especially for their families, because of the cultural gap as well as the locations of the projects, which are usually in remote areas.

Ramadan: The Fasting Month (Rank: 3)

The Ramadan month is the lunar month during which Muslim people fast from sun rise to sun set. The official Working hours during Ramadan are 6 hours for Muslim workers. During Ramadan productivity decreases and the project monthly progress rate decreases tremendously which could cause schedule delays. Also, if Ramadan came in the Summer Season, productivity could even suffer more. All of this should be taken into account when planning the schedule of a Saudi Power Generation Project.

Another cascading effect of the month of Ramadan is Customs Clearance Delay. There is likely to be some delay in the processing of materials and equipment through Customs. This will mean that items may arrive on site later than expected.

Women Participation (Rank: 2)

Saudi Arabia has some specific working limitations and regulations related to Women's participation in construction projects. With time this was reflected on the working environment. For example, most commercial and construction facilities are not prepared for separation.

It would be hard for consultants' and contractor's working ladies to adapt easily in the Saudi culture. One way to deal with this threat is to totally avoid it by not bringing any woman to a Saudi Power Generation Project. However, this will have a negative impact on some consultants and contractors since women are valuable part of their organizations' resources.

Local Manufacturers' Working Style (Rank: 1)

The difference between the working styles of EPC Contractors and local Saudi manufacturers may cause a lot of miscommunication. The “Cooperation Period”, which is the time period needed by one party to adapt to the other party’s working style, is considerably longer than in other parts of the world. In Power Generation projects, manufacturing information and design data will not be all available at the time of issuing the PO and some assumptions will be included in the PO. However, the local manufacturer will not start productions even for the basic and standard parts, because the design data are not completed.

This style of work causes a delay in the delivery time. Consequently, the project schedule will be delayed, because the schedules of SEC Power Generation Projects always has limited buffers. All of this delays and cost increase are caused by local manufacturer despite the fact that main contractor is helping them with the technology, system engineering, and production management. Also, when the elementary production started and the assumptions were changed the local manufacturer will not just ask for more money; they will also ask for more time which means more project delay. That is why some EPC contractors are reluctant to deal with local manufacturers.

4.2.2.3 Economic Threats

Nine responses identified five economic threats. Only one was highly ranked. The identified economic threats are:

Infrastructure (Rank: 3)

Since there are currently many construction projects being simultaneously executed in Saudi Arabia the capacity of the local infrastructure is being tested. For example, the

Saudi ports with their current capacity cannot handle the high demand of these construction projects as well as all other commercial activities.

On the other hand, some major projects will be executed in remote areas that don't have a nearby sea port capable of transporting large equipment. For example, the nearest sea port to Shuqaiq Thermal Power Plant Project is Gizan port, which is a relatively small marine port. In addition, other major projects will be executed in Gizan area at the same time. One of Gizan's major projects is a $5.9 Billion Saudi Aramco Refinery.

Therefore, it is almost impossible to transport extremely heavy equipment to some project sites through the nearest seaport. An alternative port close to the project site capable of receiving this heavy equipment must be utilized. This heavy equipment will then be transported by land over long distances, which usually cause cost increase and schedule delay.

Also, Saudi Arabia is heading toward industrialization and many industrial facilities are being constructed and operated in remote areas. These new industrial facilities need electricity. Hence, new generation plants will be built and operated in remote areas. For example, generation plants are being built right now in Ras-AlKhair and Waad ALShamaal which are very remote areas in Saudi Arabia. Therefore, there are infrastructural threats that can be solved by building new roads and/or airports.

On the other hand, due to the unreliability of the main local telecommunication services in some remote areas in Saudi Arabia, the contractor may not be able to connect to his

main network and utilize his Process Capital. A company's Process Capital contains its effective and efficient processes and intangible resources.[1]

Prices Inflation of Local Services & Material (Rank: 2)

In the recent years, there were high rates of inflation of local services and goods such as real state rent. Also, prices of main local materials such as Cement are fluctuating.

Another related threat is the possibility that the Saudi government could decrease the subsidies resulting in large increase in cost of fuel in the local market. Such a step is considered an inflationary factor that will affect the profitability of projects. For example, cost of internal transportation could increase.

Economic Boom and Availability of Resources (Rank: 2)

Saudi Arabia is experiencing a high rate of economic growth with an increasing number of new projects, including power generation projects. Therefore, a shortage of qualified EPC Contractors, who could participate in the Saudi Power Generation projects, is expected. This will not be limited to the main contractors only; numbers of available consultants and subcontractors could also be constraint. Such a threat could cause reduction in quality, delay, and additional cost in a Saudi Power Generation Project.

On the other hand, there are many projects that are being executed at the same time and in the same region. For example, the west coast of Saudi Arabia is full of new major projects that are being executed at the same time. Hence, getting the required supply of concrete in economically active regions in the right time can be a real challenge. Cement

[1] Benjamin Matthies, "Process Capital: A Synthesis of Research and Future Prospects," *Knowledge & Process Management* 21, no. 2 (2014).

has to be imported from outside these regions which will increase the final cost of concrete.

Currency Liquidity (Rank: 1)

The Saudi currency (Riyal) is not a very liquid currency in the international currency market. In other words, availability of the currency in the markets outside Saudi Arabia is limited.

High Competition (Rank: 1)

With the entry of Korean and Local contractors, Saudi Power Generation Projects have become a very competitive market. It has also become very competitive because the Middle East, primarily Saudi Arabia, has substantial new power prospects that entice interest and competition between major EPC contractors.

4.2.2.4 Environmental Threats

15 responses identified five environmental threats. Two of them were highly ranked. The identified environmental threats are:

Weather (Rank: 5)

The working environment in Saudi Arabia especially in the coast sides, can have Sand Storms, unseasonal heavy rains, high temperature and high humidity during the summer months. These weather conditions could affect the project progress by limiting working hours.

Ambient conditions of Saudi Arabia are very harsh. During summer season ambient temperature could reach 50ºC. This fact requires that all equipment installed in Saudi Generation Project shall be designed for 50ºC. This mandate poses real technical challenges for designer and suppliers. It also causes price increase that the client has to bear. Another example is the Isolation System Class as well as the Ingress Protection ratings (higher IP Grade) that has to be stringent because of the sand storms.

Moreover, it highly probable that the project progress will be affected during the summer season due to delays in construction activities caused by high outdoor temperature. While in the winter season severe winds and heavy rain are very likely.

Environmental Regulations (Rank: 4)

In general, the environmental regulations in Saudi Arabia are normal and not as tight as in the developed countries. Nonetheless, there are some environmental elements that can be sources of threats. One example of these elements is the environmental legislations and conditions. These conditions can be very challenging for major equipment manufacturers. Therefore, there is a chance that only a very few qualified manufacturers will be able to satisfy these conditions. Hence, main contractors could find themselves facing an oligopoly situation (monopoly by more than one, but by a very few). In other words, the prices of those few manufacturers, who are able to satisfy those environmental conditions, will be very high since they will take full advantage of the limited competition.

When retrofitting an old power plant, there is an environmental threat because new environmental requirements will be imposed to an old design, which can be very challenging. It is much easier to build a new power plant than to retrofit an old one and satisfy all new environmental requirements as well.

Also, the Dewatering System in a Thermal Power Generation project must be clarified according to specific procedures before being returned back to the sea. Finding dumping areas for projects' disposables material can also be very challenging.

Finally, environmental regulations are increasing and could affect the commercial feasibility of projects.

Polluted Working Sites (Rank: 2)

Some Saudi Power Generation Projects are located near refineries and petrochemical plants. Hence, there is a potential health risk to workers from toxic emissions such as Hydrogen sulfide (H_2S) or Sulfur dioxide (SO_2).

Power Plants Fuel (Rank: 2)

The public opinion of fossil fuel fired gas plants could become very negative. Demand for the development and utilization of renewable technologies could force the Saudi government to shift to the renewable sources of energy. Also, there is a chance that environmental regulation will limit the type of fuel used in power plant to the natural gas only. Nonetheless, Saudi Arabia is an oil rich country. Hence, none of the Saudi Power Generation plants are fired by coal which is a much more polluting source of energy.

Power Generation plant causes air pollution. There is a chance that environmental regulation will limit the type of fuel used in power plant to natural gas only and prohibit companies from using liquid fuel such as Heavy Fuel Oil and light crude oil.

Availability of Fresh Water (Rank: 2)

Fresh water is not one of Saudi Arabia's natural resources. The limited availability of fresh water limits the optimization of the design and increases the capital cost of the

power plant. For example, an Air Cooled Condenser (ACC) is more expensive than a cooling tower; also, it is less effective. Moreover, essential water, which is needed for plant operation such as the steam closed cycle, has to be transferred by pipe or trucks from the National Water Company (NWC) for long distances.

4.2.2.5 Technical Threats

21 responses identified six technical threats. five of them were highly ranked. The identified technical threats are:

Local Manpower (Rank: 5)

Availability of skilled Saudi manpower was highlighted as a social theat. A very similar threat was raised in the technical category. Five responses pointed out the possibility that there are not enough qualified, skilled, or semi-skilled Saudi resources (including engineers). For example, there are not many certified Saudi specialists for NDT, Cable joints & termination, and standardized ASME welding.

Also, training usually takes relativity long time, in some cases more than six months, which is a period of time that is not tolerable in a tight project schedule.

Stringent Specs and Standards (Rank: 4)

SEC specifications are written by engineering firms and are over-specified. They are very detailed, specific and above the market standards. Such specifications will make the price high and will limit the optimization of engineering solutions. Also, they are far-off from the manufacturer's current state of the art specifications. For example, lube oil pump is directly coupled to the generator which is an old design. Other example, is the

redundancy of plant's electrical distribution system. The benefit received from such a redundancy doesn't justify the additional cost.

SEC needs to be updated to today's international engineering standards to reduce discrepancies between them and a specific scope of work. In general, they should be more performance based and aligned with manufacturer's standards.

In addition, not a lot of manufacturers can produce 60 Hz generation plants' equipment. Also, paying a premium is required to transform a new technology into the 60Hz setting.

Availability of Technical Data for New Projects (Rank: 4)

Some of the Saudi Power Generation projects are conversion projects, also known as Brown-Field-Projects. In this type of projects new facilities are being added to an existing one. For example, a Simple Cycle Power Plant can be converted into a Combined Cycle Power Plant by adding Heat Recovery Steam Generators (HRSGS), Steam Turbines, and all associated systems and equipment to the existing Simple Cycle Power Plant. The availability of current technical information of existing facilities or the lack of could be a risk. This is especially true in the Power Plant Expansion Projects.

These types of projects can be technically challenging since you may not have all the technical information for the existing subsurface conditions and even site visits may not be sufficient to determine hidden conditions. The completeness of this information is necessary for designing the new facility as well as pricing the bid proposal. If the Client's bid documents are not technically complete, it will be hard to bring about a precise technical solution; consequently, tender price will not be accurate. Generally, international contracting practices recognize that differing site conditions may be a basis of change. If this is not the case, then the main contractor should consider other ways to

mitigate this threat. For example, potential price and schedule margins may be added to their bid to accommodate unforeseen conditions. This can be a threat to the client as well.

In addition, early technical studies, which are required for completing the preliminary design and pricing the bid proposal, such as Geotechnical, Topographical, and Bathymetric studies, are sometimes provided by the client for guidance only. So there is the threat of these studies being inaccurate. Although the contractor is given the option to conduct these studies, some don't do them. Hence, the contractor's estimates are based on the provided studied plus some risk margin i.e. contingency reserves.

Local Suppliers/Subcontractors (Rank: 3)

There are not enough local technical services companies in Saudi Arabia. For example, there are shortages of important services for Power Generation projects such as standardized welding, pre and post weld Heat Treatment, and testing & commissioning special equipment.

Moreover, capable local subcontractors are very few, especially the ones that can work in large and complex projects. A subcontractor capability is defined by two factors. The first is how many and how big the heavy equipment the subcontractor has. The second factor is how many skilled and labor manpower the subcontractor has. Also, SEC mandatory list of the approved subcontractors is limiting the EPC Contractor options.

In addition, some local suppliers lack the technical knowledge needed for power generation projects. In other words, they are not technically reliable. Also, local subcontractors' experience with Health, Safety, and Environmental (HSE) requirements is limited. Also, some of the local suppliers don't run a coherent and impervious quality

management systems in their facilities. Others have poor capability in keeping the delivery schedule, which could cause serious effect on overall project progress.

Technical Gaps in Tender's Specifications (Rank: 3)

During the bidding stage, client specifications keep changing i.e. technical requirements are given in multiple steps and are not all given at the beginning of the bidding process. For example, a tender for one of Saudi Power Generation Project had eight (8) addendums.

Representation of International Suppliers (Rank: 2)

Representation of suppliers in Saudi Arabia is inadequate to support Saudi Power Generation projects by providing spare parts, tools, skilled manpower in a timely manner. Currently, many of these services have to be mobilized from abroad. Again, the visa regime makes the problem worse. This will impose time delay and more cost on a Saudi Power Generation project.

4.3 Identified Opportunities

13 responses identified opportunities in Saudi Generation Projects. The following are the major identified opportunities:

4.3.1 Economic Opportunities

Saudi Arabia is a wealthy nation that is financially stable. Its economy is steadily growing. This will give some certainty and reduce contingencies. Payment delays or project cancellation are unlikely. Also, negative cash flow, caused by delayed payments from the client, are unlikely.

Furthermore, there is financial support from the government to the power generation industry. For example, the Saudi government recently gave interest free loans that amounts to billions of USD to SEC.

In addition, Saudi Arabia is heading toward industrialization and many industrial facilities are being constructed and operated which requires electricity. Hence, new generation plants need to be built to support these new industrial facilities.

Another advantage is the low possibility of currency fluctuations since the Saudi currency is pegged to the world's reserve currency, the US Dollar.

Moreover, the Saudi Market is known as a free market that is located in the center of the world. Sizable and capable ports are accessible. Also, it is easy to move capital to and out of Saudi Arabia.

Finally, working in Saudi Arabia can be an opportunity for western professionals, because of two reasons: (1) low cost of living compared to their countries and (2) there are very few channels for entertainment.

4.3.2 Social Opportunities

Saudi population growth rate is very high compared with the global average. This can be an opportunity for more power generation projects in the future.

Also, when the government of Saudi Arabia decide to go for a project, there will be social acceptability and there will be no community opposition. As a matter of fact, the surrounding communities will welcome major Saudi Power Generation Projects.

4.3.3 Environmental Opportunities

Currently, the Saudi environmental requirements are normal compared to the rest of the world. They are very similar to the American and less strict than the European requirements. However, the wave of global environmental concerns that has been growing rapidly in the recent years could reach the Saudi shores. Consequently, Saudi environmental regulations, that are relevant to generation projects and plants, could be tightened even more.

4.4 Summary and Analysis

Through the ten experts' interviews, 101 responses were received. 88 of which identified 27 threats in Saudi Power Generation projects. The other 13 responses identified some opportunities in these projects. Out of the 27 identified threats 17 were major threats since they were highlighted by at least three experts.

4.4.1 Highly Ranked Threats

Of all the categories assessed, the legal category was the highest ranked threat category. 26 of the received responses were related to this category and they identified six major threats. The Technical category came second with 21 responses and five major threats. The third highest ranked threat category is the social category. 17 responses identified five social threats; three of which were major. The environmental and economic categories had lower scores, since they received only 15 and 9 responses, respectively.

Acquiring the needed skilled manpower and labor to work in Saudi Power Generation projects is the highest threat identified, because of two main reasons: (1) there are not enough qualified Saudi in the workforce and (2) there are challenges in recruiting from

abroad. These two reasons were identified by many experts. In particular, seven responses were about the fact that the size of the Saudi workforce willing to participate in industrial projects is limited; and five other responses pointed out the fact that there are not enough Saudis who are technically qualified to work in a Power Generation project. The second reasons, which was the difficulty of recruiting from abroad, was mentioned by seven experts. Also, three other experts pointed out the challenges that could be caused by the Saudization requirements.

Another threat that was highly ranked by the interviewed experts was SEC contracting requirements. Six experts stated that the General Terms and Conditions of SEC Power Generation Project Contracts had some imbedded threats. Some of the clauses result in the contractors increasing their contingencies.

Saudi Arabian weather was also highly ranked as threats. This threat was identified by four contractors' representatives and one client's representative.

4.4.2 Main Opportunities

Thirteen of the received responses identified opportunities. Some of the identified opportunities were related to the nature and strength of the Saudi economy. Many of the interviewed experts saw the Saudi economy as a free market economy that is stable and growing. They have also shared their positive outlook for the power generation industry in Saudi Arabia. They believed that there will be many new generation projects in the near future because of the high population growth rate as well as the industrialization of the Saudi economy. Another identified opportunity is the current Saudi environmental requirements and regulations. They were viewed as normal requirements and less strict than the European environmental regulations.

4.4.3 Discrepancies

In general, there was general consistency in the responses received. Very few discrepancies were identified. The first one was related to the Saudi Currency, the Saudi Riyal. Many responses appreciated the stability of the Saudi Currency since it is pegged to the world's reserve currency, the US Dollar. However, one contractor's representative was worried about the liquidity of the Saudi Riyal outside Saudi Arabia.

The other inconsistency was related to the payments delays. Many experts considered Saudi Arabia as a wealthy nation with a stable and growing economy. Even more, one expert stated that the current economic condition of Saudi Arabia gives some certainty and reduces the possibility of facing payment delays or negative cash flows periods. That is why the Saudi Economic position was considered as an opportunity in this report. However, one expert, a contractor's representative, was concerned about payment conditions, imposed by the client (SEC). He believed that they could create a negative cash flow for the main contractor during a large portion of the project execution phase.

The third and final noted discrepancy was related to Saudi infrastructure. Many experts appreciated the current capabilities of the Saudi infrastructures. However, one experts thought that they are being tested because of the high number of project that are being simultaneously executed. Another expert expressed his concerns regarding the current capabilities of some seaports located near small cities such as Gizan seaport.

4.4.4 Comparison with the Literature Review Findings

This section compares the results of this research with the findings from the literature review, which was focused on identifying external risks in Saudi Construction Industries.

4.2.4.1 Similarities

A quick comparison between Table 13 (above), which lists the highly ranked external threats that were identified through the literature review, and Table 16 (above), which listed all the threats that were identified through this primary research, reveals the following similarities:

- There are still shortages of qualified manpower in the Saudi Construction Industry.
- There are not many qualified and experienced local subcontractors in the power generation industry.
- Bureaucracy, in particular the issuance of Work permits, still form a challenge for main contractors.
- There are still some constraints on employment of expatriates such as obtaining working visas.
- Saudization requirements are negatively affecting the success of the Saudi projects.
- It is still takes a long time to approve materials or prospective manufacturers.

Similar external opportunities were also identified through the literature review and experts' interviews. The first one is the strength of the Saudi economy and its high-growth rate. The second one is the free market policy adopted by the Saudi government.

4.2.4.2 Difference

Some of the main external threats, which were identified through the literature review, were never mentioned by the interviewed experts. In the author opinion, the reason for that could be one of the following:

- low number of interviewed experts i.e. small sample
- some of the threats in the Saudi Construction industries do not apply to the Saudi Power Generation sub-industry
- the root causes of these threats were eliminated in recent years

Specific examples of main external threats that were never identified by the interviewed experts, but were highlighted by early studies are the following:

- Lack of Standard of measurement
- Long warranty period
- Slowness of owner's decision-making process
- Selecting the Lowest Bidder (in Saudi Power Generation Project the lowest *Compliant* Bidder is selected)
- Delay in the settlement of contractor claims
- Change order negotiations
- Shortage of construction materials in the Saudi market

Nonetheless, there is one particular threat that was identified in early studies as a threat, but was considered by the interviewed experts as a far possibility, at least in Power Generation Projects. That threat is delay in progress payments in power generation projects. In a matter of fact, some of the interviewed experts considered the payment issue as one of the external opportunities in Saudi Power Generation Projects.

4.5 Recommendations

Both sellers and buyers should utilize the results of this research to improve their chances of successfully building more efficient Saudi power generation plants. The seller, mainly SEC, can focus on eliminating the major threats in order to reduce the contingencies in the contractors' bid proposals. They should also maximize the likelihood of opportunities occurring as well as their magnitude of their positive impact.

Consequently, the capital of the client's new power generation plants will be more efficient.

On the other hand, by managing all identified external threats, main contractors can increase their chances of having a timely completion of their Saudi power generation projects and avoiding a budget overrun. They can do so by minimizing the likelihood of the identified major threats happening. Also, appropriate responses should be put in place to reduce the impact of these threats in case they occurred.

Finally, whomever they are providing their services to, consultants should use the findings of this research to their clients' benefit and increase the likelihood of the project success and reduce the impact of these risk in case they occurred.

However, to fully benefit from these findings, Saudi power generation project participants must compete the following steps [1] [2] [3] [4]

- A risk register must be created to keep and track risk information. It shall be updated with newly identified risk throughout the project life cycle.
- Risks must be analyzed, their root causes, triggers, and effects must be defined. The extent of their impacts must also be identified.
- Preliminary responses shall always be added to the risk register as they are identified. Improving these potential responses and finding other alternative responses shall be part of a later process, Plan Risk Responses process.

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[1] Project Management Institute., *A Guide to the Project Management Body of Knowledge (Pmbok Guide)*.
[2] Project Management Institute., *Practice Standard for Project Risk Management*, 29.
[3] Mulcahy and Mulcahy, *Risk Management Tricks of the Trade for Project Managers : And Pmi-Rmp Exam Prep Guide*.
[4] Rita Mulcahy, *Pmp Exam Prep : Rapid Learning to Pass Pmi's Pmp Exam-- on Your First Try!*, 6th ed. (S.l.: RMC Publications, 2009).

- Each major risk should be assigned to a risk owner. A risk owner will be responsible for following the status of his assigned risks, monitoring their triggers, and implementing their planned response(s).
- All of this new data should be added to the risk register, monitored, and updated as the project progresses.

CHAPTER 5 - SUGGESTION FOR ADDITIONAL WORK

In this study only two techniques were used for risk identification, expert interview and prompt list. Similar studies that utilized other risks identification tools and techniques, such as the Delphi technique and brainstorming session, can be completed to identify other risks in Saudi Power Generation Projects.

Moreover, this research applied only one step of the project risk management, which is the Identify Risks process. Therefore, the output of this research can be utilized as an input for the following steps in the Risk Management Process. For example, Quantitative Risk Analysis can be performed for each of the identified risks. Also, appropriate response for each identified risk can be elected and planned for in order to avoid, transfer, or mitigate that risk.

On the other hand, new researches can be undertaken to (a) identify the root causes of all identified risks in this research, (b) nominating the appropriate potential risk owners, and (c) pinpoint the risk triggers for each identified risk.

Finally, further research is proposed to answer the question: “whether there is a direct correlation between the current level of development in a country and the type of threats in its major construction projects?” For example, would bureaucracy be highly ranked as a threat in a construction project that is being executed in an underdeveloped country? Another example is the availability of skilled manpower in a developed country.

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APPENDICES

Appendix - A

Appendix A: SEC Electrical Data[1]

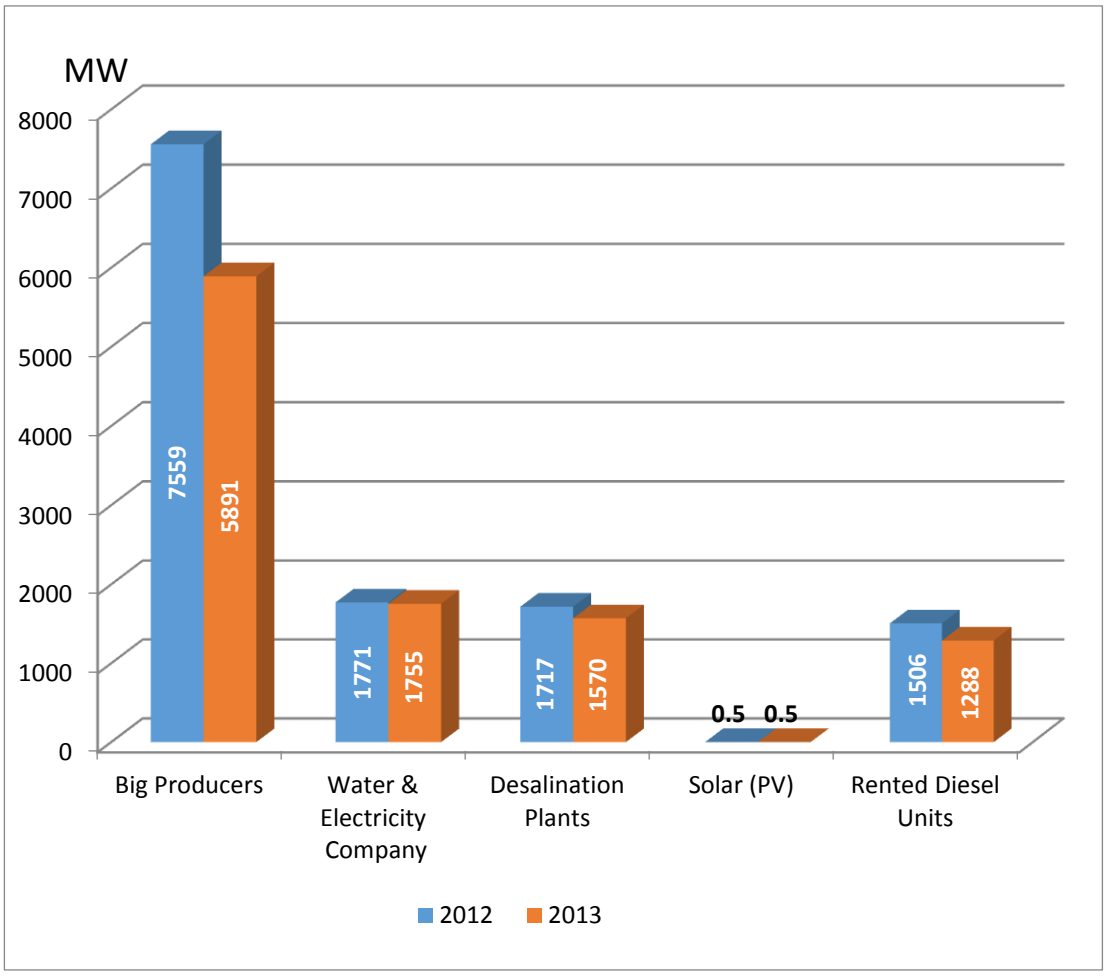
Generation Capacity (MW)

Details \ Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Growth Rate during period (%)	Average annual growth rate (%)
Steam	5672	6748	8747	10165	10293	10293	11472	12651	12795	12795	12795	13986	13986	14686	15.9	7.6
Gas	13229	13318	13486	13684	14013	15273	15843	16984	18915	22389	24495	25281	26327	24416	84.6	4.8
Combined Cycle	2387	2390	2484	2484	2445	2444	2385	2385	2371	2369	2300	2299	2331	6342	165.7	7.8
Diesel	772	774	740	685	672	630	608	583	389	360	383	358	439	464	-40	-3.8
Total Power Plants Capacity at the end of year	22060	23230	25457	27018	27423	28640	30308	32603	34470	37913	39973	41924	43083	45908	108	6.3
Rented Diesel Units	-	-	-	-	288	411	358	354	488	767	724	1057	1288	1506	422.8	20.2
Solar (PV)	-	-	-	-	-	-	-	-	-	-	-	0.5	0.5	0.5	0	0
Desalination Plants	3436	3096	2946	2866	2445	2539	2905	2395	2444	1954	2059	1811	1570	1717	-50	-5.2
Water & Electricity Company	-	-	-	-	-	-	-	-	-	945	1739	1753	1755	1771	87.4	17
Big Producers	294	187	256	207	370	711	1429	1597	1840	2906	4643	4602	5891	7559	2471	28.4
Total Available Capacity	25790	26513	28659	30091	30526	32301	35000	36949	39242	44485	49138	51148	53588	58462	127	6.5

[1]SEC-IRID.

Ye(SEC-2014)ar / IRID Details	2012	2013
Big Producers	5891	7559
Water & Electricity Company	1755	1771
Desalination Plants	1570	1717
Solar (PV)	0.5	0.5
Rented Diesel Units	1288	1506

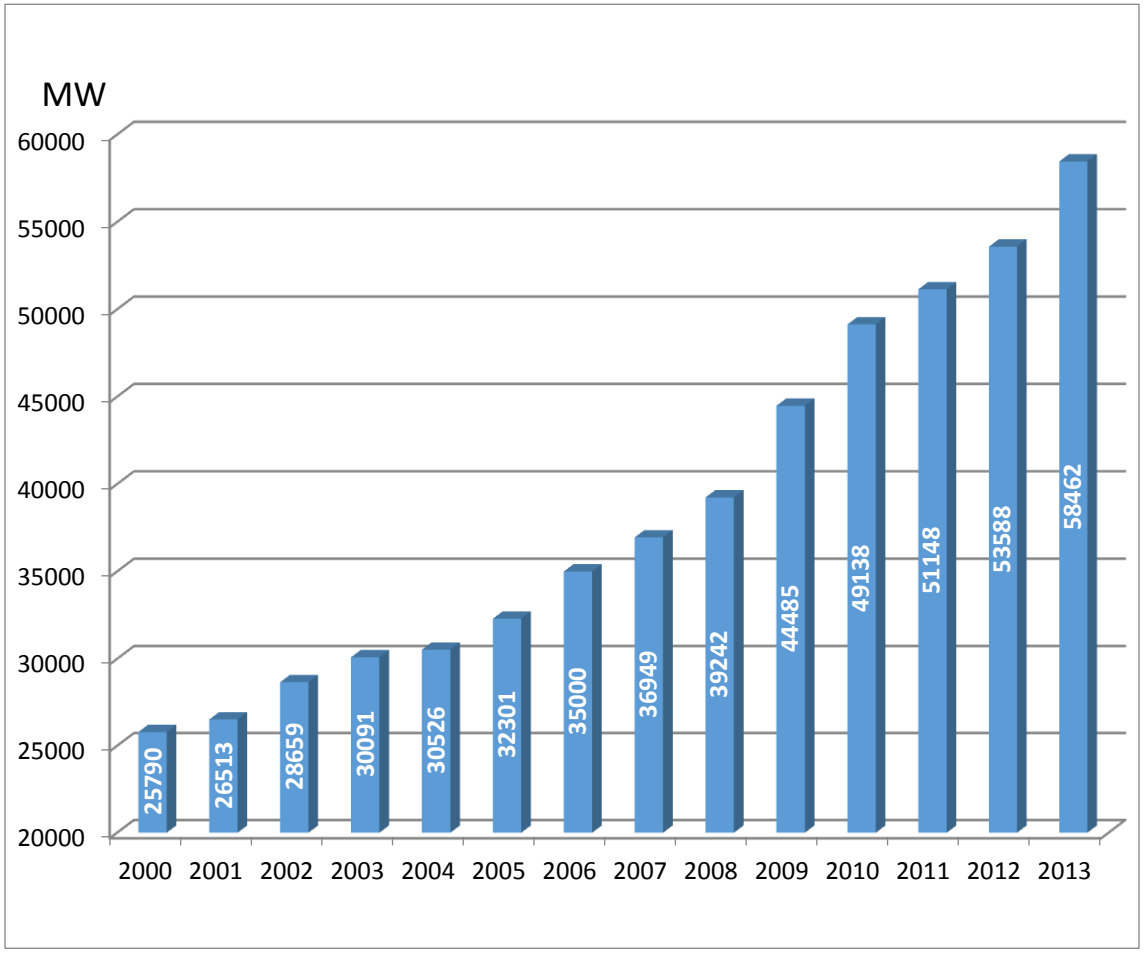
Contribution of Other Producers at the Peak Load During (2012-2013)



Contribution of Other Producers at the Peak Load During (2012-2013)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Capacity (MW)	25790	26513	28659	30091	30526	32301	35000	36949	39242	44485	49138	51148	53588	58462

Development of total Available Capacity during (2000-2013)



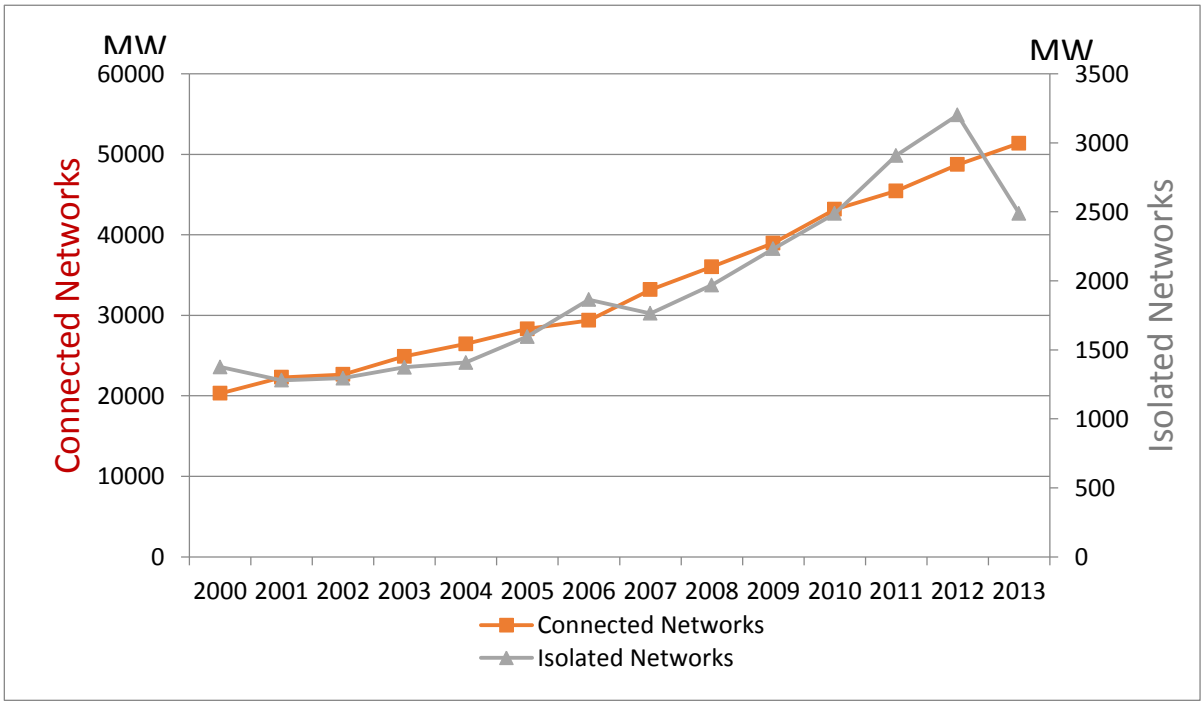
Development of total Available Capacity during (2000-2013)

Plant Name	Unit Type	Capacity (MW)
Al Qurayah Combined	Combined Cycle	1000
Al-Qurayyat	Gas Turbines	120
Juba	Gas Turbines	125
Ash-Shuaybah	Combined Cycle	760
Rabag 2	Steam Turbines	700
Tabuk 2	Gas Turbines	124
Al-Wajh	Gas Turbines	180
Najran	Gas Turbines	112
Total		3121

Actual Generation Capacity Added in SEC's Power Plants (MW) During 2013

Year	Connected Networks	Isolated Networks	total Peak
2000	20297	1376	21673
2001	22302	1280	23582
2002	22643	1295	23938
2003	24898	1374	26272
2004	26439	1408	27847
2005	28317	1596	29913
2006	29376	1864	31240
2007	33189	1764	34953
2008	36030	1970	38000
2009	38967	2233	41200
2010	43173	2488	45661
2011	45458	2909	48367
2012	48737	3202	51939
2013	51375	2489	53864
Average annual growth rate (%)	7.4	4.7	7.3

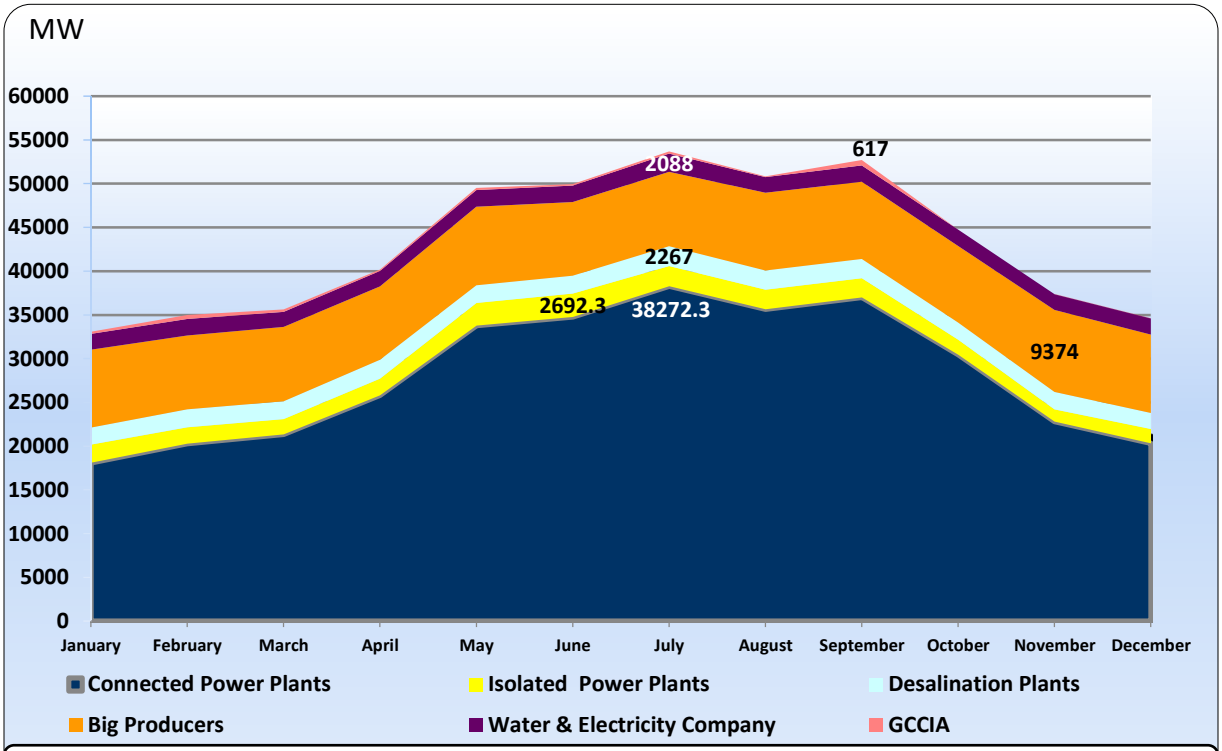
Development of Asynchronous Peak Load (MW) during (2000-2013)



Development of Asynchronous Peak Load (MW) during (2000-2013)

Month	Generation Peak Load*		Imported Load Participated at Operating Area Networkd Peak Load				Networks Load	Total Load
	Connected Power Plants	Isolated Power Plants	Desalination Plants	Big Producers	Water & Electricity Company	GCCIA		
January	18,100	2,080	1,944	8,906	1,805	245	29,749	32,258
February	20,281	1,882	2,050	8,441	1,884	457	29,642	31,305
March	21,349	1,743	2,041	8,500	1,718	278	33,872	35,060
April	25,809	1,909	2,161	8,384	1,767	153	38,485	39,653
May	33,759	2,606	2,025	8,980	1,903	244	47,310	48,135
June	34,759	2,692	2,036	8,417	1,881	169	49,546	50,410
July	38,272	2,317	2,267	8,499	2,088	246	52,380	53,692
August	35,650	2,238	2,192	8,888	1,787	85	49,727	50,900
September	37,013	2,187	2,201	8,822	1,867	617	51,840	52,256
October	30,459	1,704	1,968	8,751	1,870	0	43,865	45,344
November	22,811	1,394	1,994	9,374	1,799	0	35,428	39,482
December	20,300	1,656	1,839	8,961	1,852	0	32,683	35,174
During Year	38,272	2,489	2,267	9,374	2,088	617	52,380	53,864

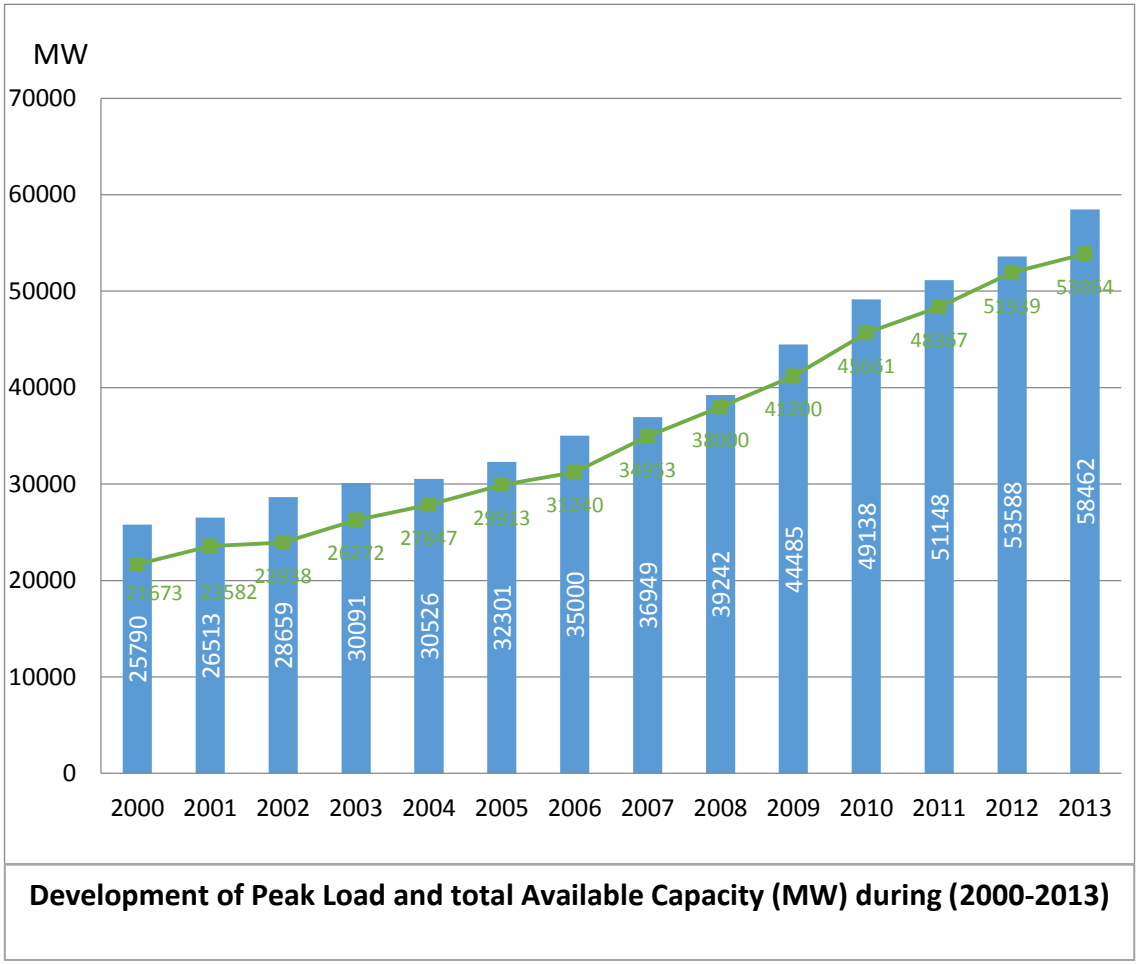
Monthly Peak Load (MW) during 2013



Monthly Peak Load (MW) during 2013

Year / Details	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Growth Rate during period (%)	A
Total Capacity at end of year	25790	26513	28659	30091	30526	32301	35000	36949	39242	44485	49138	51148	53588	58462	126.7	
Asynchronous Peak Load	21673	23582	23938	26272	27847	29913	31240	34953	38000	41200	45661	48367	51939	53864	148.5	

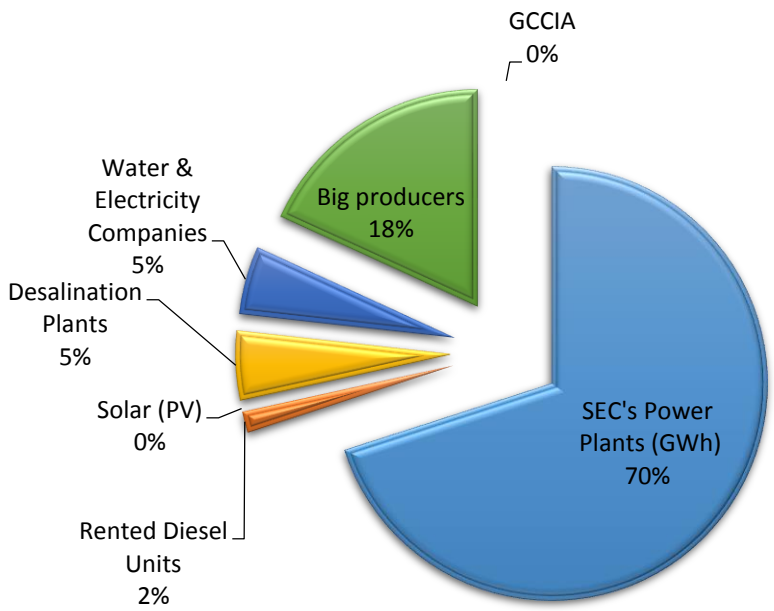
Development of Peak Load and total Available Capacity (MW) during (2000-2013)



Development of Peak Load and total Available Capacity (MW) during (2000-2013)

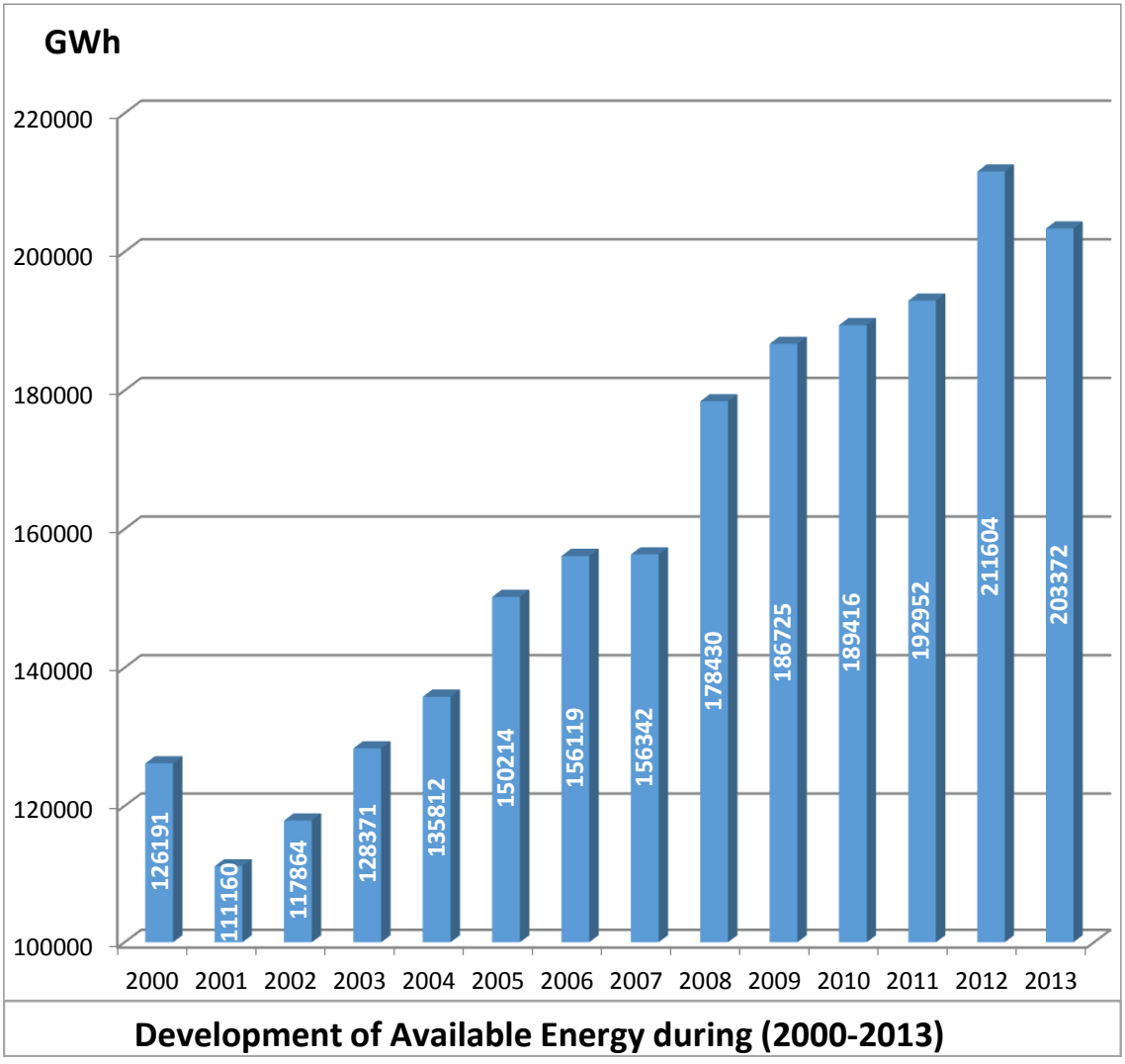
SEC's Power Plants (GWh)	198901
Rented Diesel Units	4471.6
Solar (PV)	0.78
Desalination Plants	14597
Water & Electricity Companies	14443
Big producers	51598
GCCIA	6.39

Transmitted Energy on Networks according to the Source during 2013



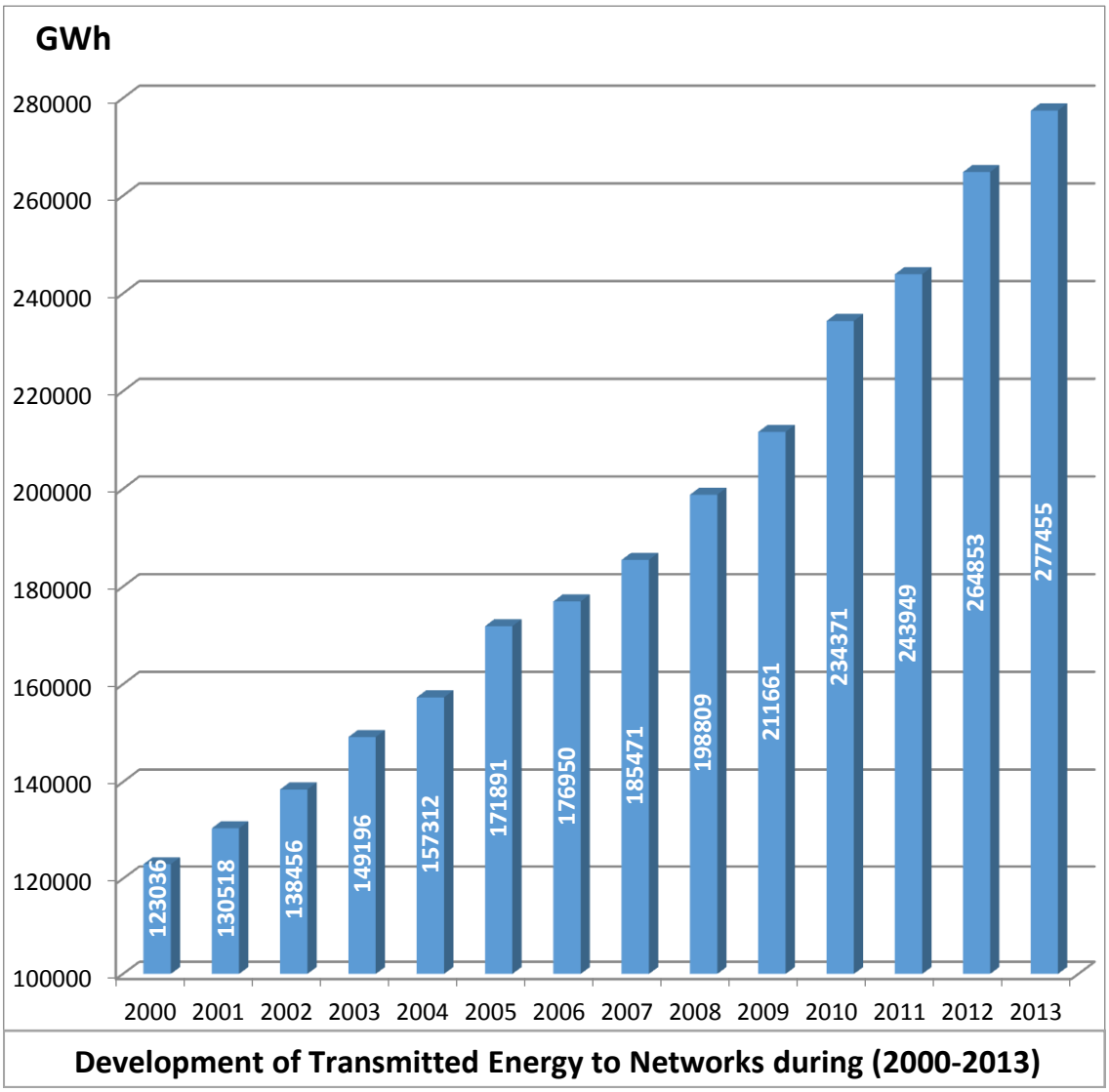
Relative Distribution of Transmitted Energy on Networks According to the Source During 2013

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Energy (GWh)	126191	111160	117864	128371	135812	150214	156119	156342	178430	186725	189416	192952	211604	203372



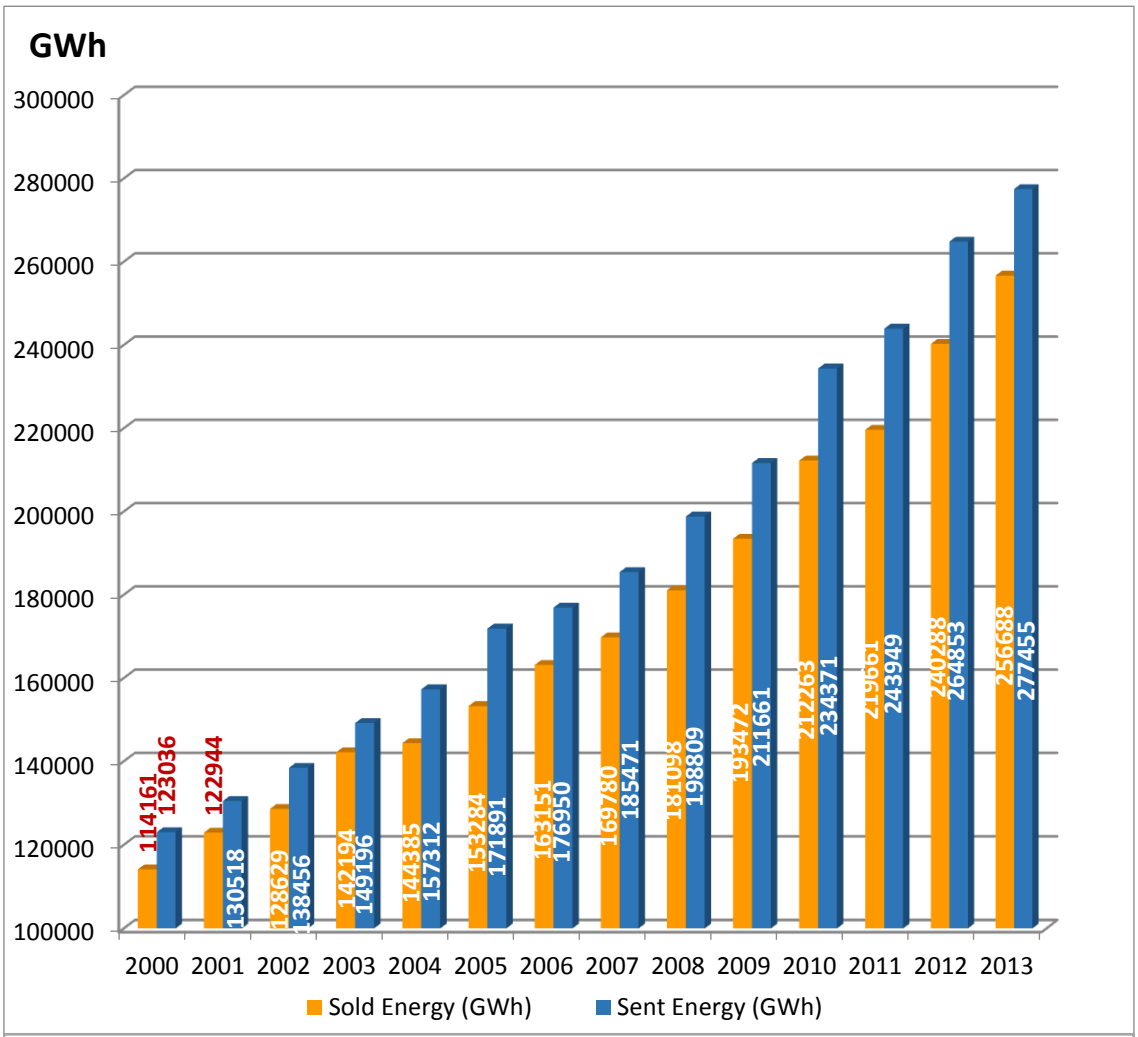
Development of Available Energy during (2000-2013)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Energy (GWh)	123036	130518	138456	149196	157312	171891	176950	185471	198809	211661	234371	243949	264853	277455



Development of Transmitted Energy to Networks during (2000-2013)

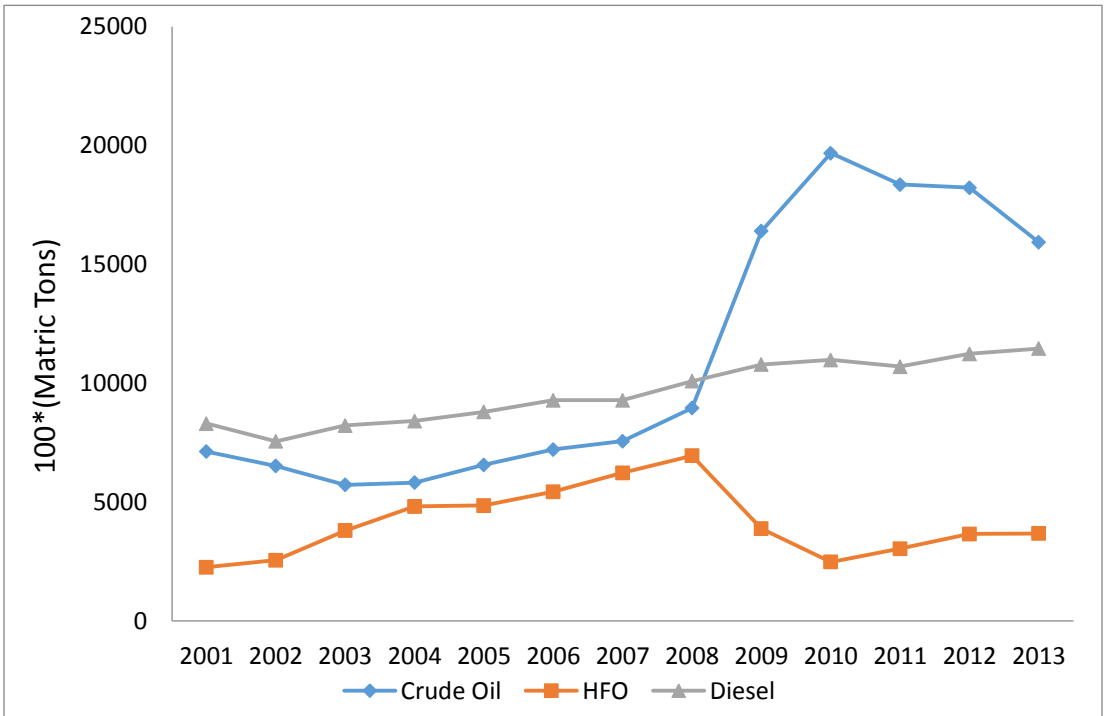
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Sold Energy (GWh)	114161	122944	128629	142194	144385	153284	163151	169780	181098	193472	212263	219661	240288	256688
Sent Energy (GWh)	123036	130518	138456	149196	157312	171891	176950	185471	198809	211661	234371	243949	264853	277455



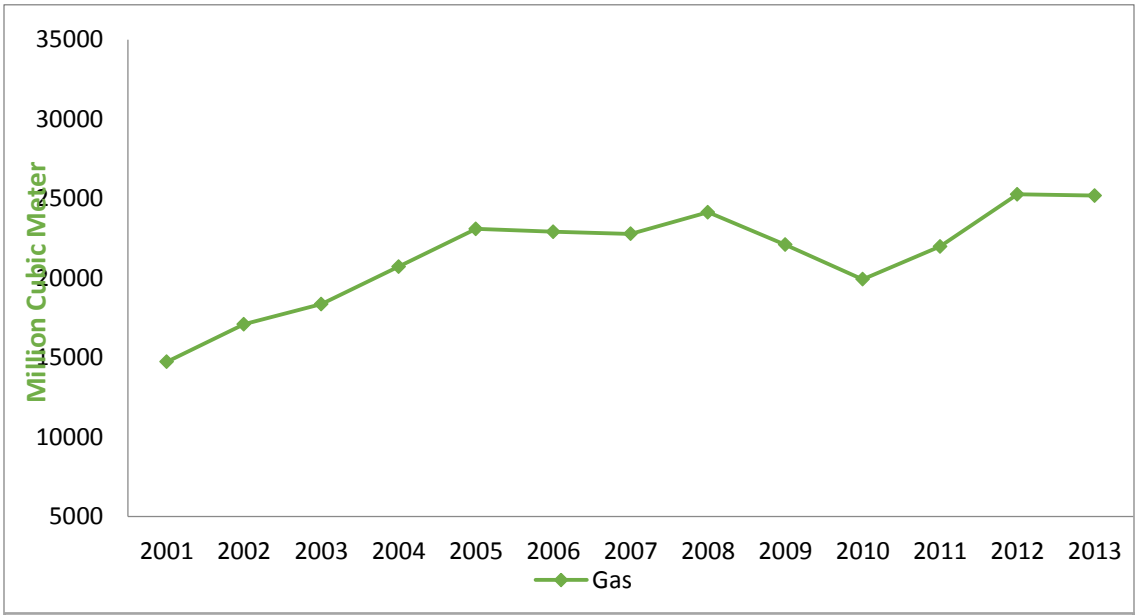
Development of Transmitted Energy to Networks and Sold Energy During (2000-2013)

Year / Detalis	Gas (Million Cubic Meter)	Crude Oil (Matric Tons)	HFO (Matric Tons)	Diesel (Matric Tons)	Total Fuel Consumed 10000*(TOE)
2001	14733	7124777	2258160	8300948	32.2
2002	17099	6520869	2559084	7559681	33.3
2003	18367	5723823	3803219	8220197	35.6
2004	20720	5823574	4814482	8412739	39.2
2005	23097	6565087	4855595	8797885	40.4
2006	22913	7210998	5436897	9285832	44.2
2007	22779	7566051	6233075	9287592	44.4
2008	24141	8955544	6949185	10088459	48.2
2009	22096	16403435	3880873	10787793	51.6
2010	19926	19681896	2482811	10983152	51.8
2011	21986	18361935	3043061	10700992	52.6
2012	25262	18223174	3658018	11236729	55.2
2013	25183	15929018	3682659	11459431	53.1

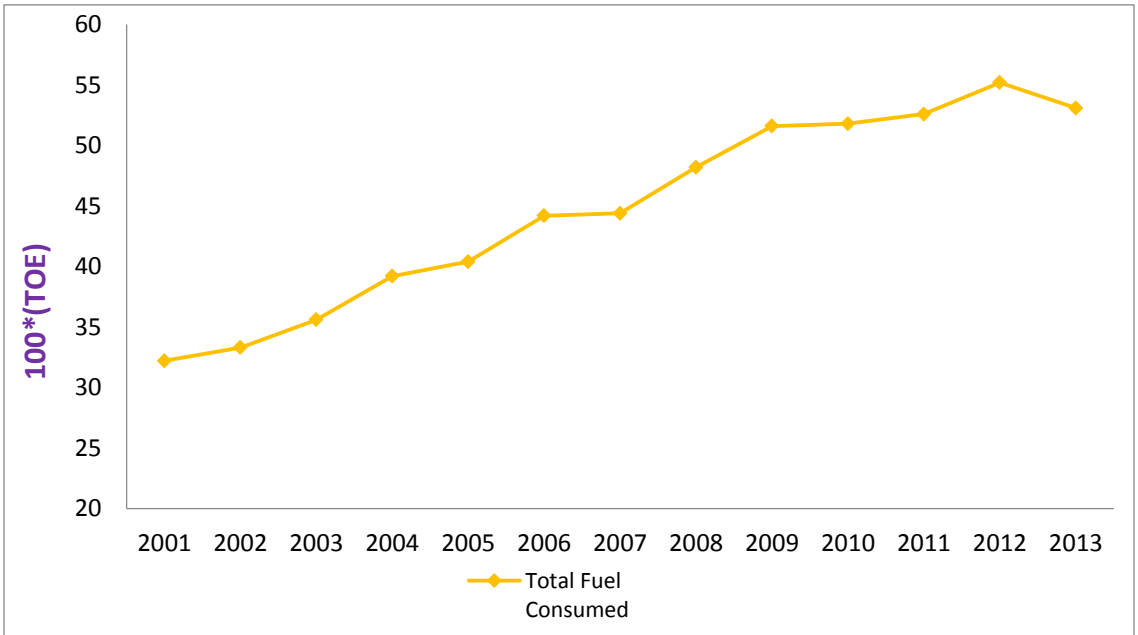
Fuel Consumed in Power Plants



Development of Fuel Consumed in Power Plants (except Gas)

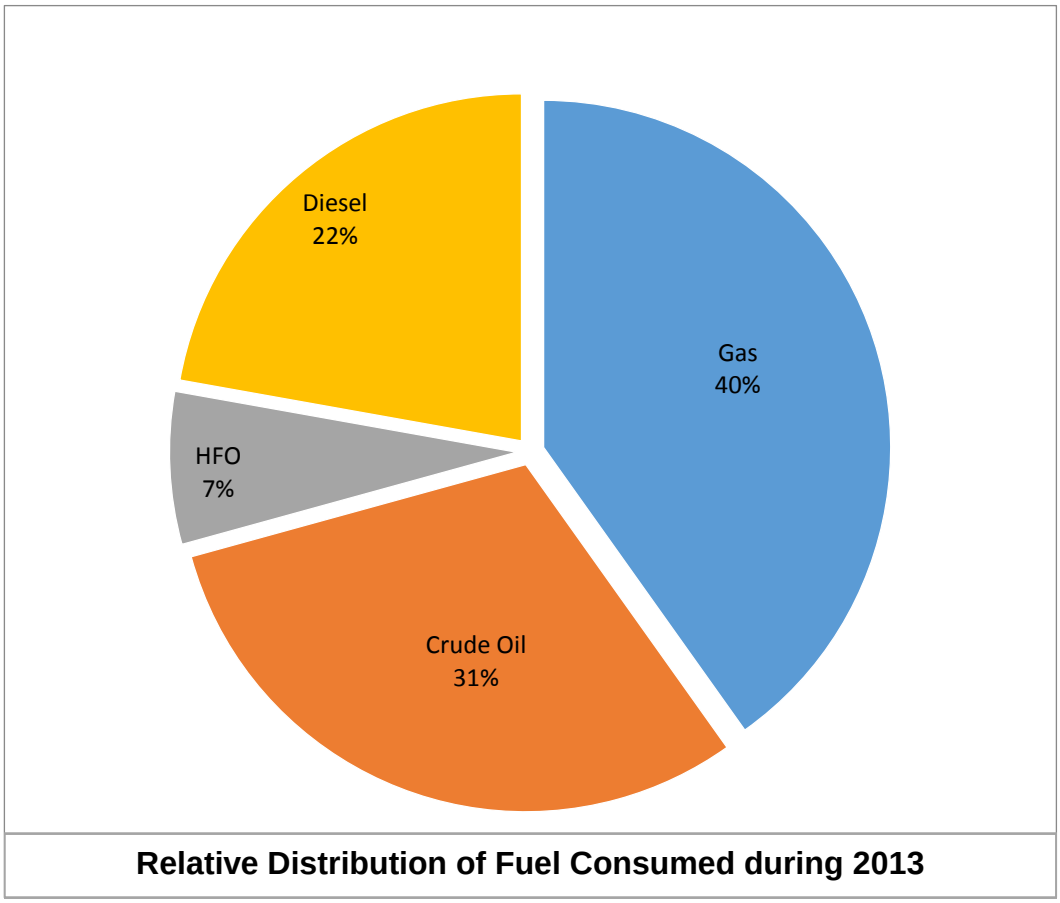


Development of total Fuel Consumed in Power Plants



Fuel Consumed by type during 2013

Type of Fuel	Gas	Crude Oil	HFO	Diesel	Total
Fuel Consumed 1000*(TOE)	21338	16242	3766	11792	55205
Percent	40.20%	30.60%	7.10%	22.20%	100%
Relative Distribution of Fuel Consumed during 2013					



Relative Distribution of Fuel Consumed during 2013

Appendix - B

Appendix B: 131 Causes of Delays Identified in ALKharashi's Study

Note: The causes of delays in each category are listed in no specific order.

Client - Related Causes of Delay	
1	Key Personal replaced
2	Owner's poor communication with construction parties and government authorities
3	Slow decision making owner
4	Lack of finance to complete the work by client
5	Poor communication by owner and other parties
6	Interference by owner in the construction operations
7	Non-payment of contractor claim.
8	Owner's failure to coordinate with government authorities during planning
9	Delay in issuance of change order by owner.
10	Uncooperative owner with contractor complicating contract administration.
11	Delay in approving shop drawings by owner.
12	Delay in approving sample materials by owner.
13	Suspension of work by owner.
14	Variations in quantities.
15	Difficulties in obtaining work permits.
16	Delay to furnish and deliver the site to contractor by owner.
17	Conflict between joint-ownership of the project.
18	Poor coordination by owner and other parties
19	Delay in the settlement of contractor claim by owner
20	Clarity of scope of change
21	Excessive bureaucracy by owner's administration.
22	Poor coordination by owner with the various parties during construction.
23	Late in revising and approving design documents by owner.
24	Delay in progress payment by owner.
25	Negotiation by knowledge people
26	Owner's personality
27	Owner's interference

Contractor - Related Causes of Delay	
1	Contractor experience
2	Poor qualification of the contractor's technical staff
3	Inefficient work-break down structure
4	Frauds
5	Frequent change of sub-contractors because of their inefficient work
6	Ineffective control of the project progress by the contractor
7	Difficulties in financing project by contractor
8	Poor coordination by contractor with other parties
9	Poor communication by contractor with other parties
10	Poor communication by contractor with the parties involved in the project
11	Inadequate contractor's work
12	Contractor's poor coordination with the parties involved on the project
13	Conflicts in sub-contractor's schedules in execution of project
14	Conflicts between contractor and other parties (Consultant and owner)
15	Delay of field survey by contractor
16	Replacement of key personnel
17	Ineffective contractor head office involvement in the project
18	Ineffective planning by contractor
19	Improper technical study by contractor during the bidding stage
20	Delay in the preparation of contractor submission
21	Delay in sub-contractor's work
22	Poor site management and supervision by contractor
23	Increase in contractor's over-head
24	Increased number of project
25	Inefficient quality control by contractor
26	Improper construction methods implemented by contractor
27	Cash flow management

28	Ineffective scheduling of project by contractor
29	Loose safety rules and regulations within the contractor's organisation
30	Other work on hold
31	Company organisation
32	Internal Company Problems
33	Delay in site mobilizations
34	Rework due to errors during construction

Consultant - Related Causes of Delay	
1	Inadequate experience of consultant
2	Internal company problems
3	Frauds
4	Conflict between consultant and design engineer
5	Replacement of Key personnel
6	Company organization
7	Inflexibility of (rigidity) of consultant
8	Late in reviewing and approving design documents by consultant
9	Poor communication between consultant and other parties
10	Poor coordination between consultant and other parties
11	Delay in approving major changes in the scope of work by consultant
12	Delay in performing inspection and testing by consultant

Materials - Related Causes of Delay	
1	Delay in manufacturing special building materials
2	Shortage of construction materials in market
3	Late in selection of finishing materials due to availability of many types in market
4	Shortage of material required
5	Changes in material specifications
6	Changes in material prices
7	Damage of sorted materials while they are needed urgently
8	Late procurement of materials
9	delay in materials delivery

Figure 8 Labour - Related causes of delay	
1	Low skill of manpower
2	The required equipment and tools are not available
3	the required labour skills are not available
4	Poor qualification of the contractor's technical staff assigned to the project
5	shortage of manpower (skilled, semi-skilled, unskilled labour)
6	lack of high-technology mechanical equipment
7	Low level of equipment-operator's skill
8	Low productivity and efficiency of equipment
9	Shortage of supporting and shorting installations for excavations
10	Failure of equipment
11	Shortage of equipment required
12	Shortage of technical professionals in the contractor's organization
13	Inadequate equipment used for the works
14	Nationality of labour
15	Personal conflicts among labour
16	Shortage of contractor's administrative personnel
17	Low productivity level of labour

Contract/relationship - Related Causes of Delay	
1	Major disputes and negotiations
2	Inappropriate overall organizations structure linking all parties to the project.
3	Original contract duration is too short
4	Lack of communications between the parties
5	Inadequate definition of substantial completion
6	Type of project bidding and award (negotiation, lowest bidder)
7	Conflict between contract documents
8	Type of construction contract
9	The scope of work is not well defined
10	Legal disputes between various parties
11	The objective of the project is not well defined
12	Unavailability of incentives for contractor for finishing ahead of schedule.
13	Ineffective delay penalties.

Other Causes of Delay	
1	Quality management system and assurance control
2	The consultant attempting to hide their mistake when the quantity amount changes
3	Insufficient allowance for employees' holidays in the schedule;
4	Inadequate original contract duration
5	Lack of clarity of drawings and specifications
6	Client need to analyze the causes of change;
7	The lack of experienced engineers engaged by consultants for high-tech works
8	Insufficient numbers of contractors to build the increasing numbers of construction projects in Saudi Arabia
9	Insufficient consideration of the behavior of people
10	Lack of regular meetings
11	Unclear scope of work to be done by staff contractors;
12	High turnover of personnel in Saudi Arabia
13	Insufficient study of all the details and capacity of the contractor before selection by client
14	Overdependence on the lowest tender amount in contractor selections.
15	Discrepancies between bill of quantities, specifications and drawings.
16	Level of salary of consultant staff
17	Lack of ethics.
18	Delayed salary payment to staff
19	Designer engineer selection of specials building material not available in the local market.

Appendix - C

Appendix C-1 Interview Introduction

The purpose of this interview is to identify potential projects risks, whether threats or opportunities, in Saudi Generation Projects that are caused by executing these generation projects in Saudi Arabia. In other words, the aim of this interview is NOT to identify all probable risks that could affect a Saudi generation projects, rather, the aim is to identify risks caused by the Saudi circumstances including economic, social, legal, and environmental conditions.

Identifying and exposing project risks will help in development of effective responses, to reduce project uncertainty and allocated contingency reserves for all parties associated with the project. This will also benefit the buyer (SEC) in the form of a lower project cost budget. Similarly, positive opportunities, when identified, can be exploited.

Five questions will be asked during the interview and notes will be taken. It is important to mention that the answers have to emphasize specific, experience-based information in order to maximize the benefit of this research.

But first, and for analysis purposes, I will have to ask you some questions about your experience and your role in Saudi Power Generation Projects.

Appendix C-2 Interviewee Background Information Form

Interviewee's Background Information

Name			
Date of Birth			
Nationality			
Company			
Experience			
Current Position			
Role in Saudi Generation Projects			
Years of Experience			
Years of Experience in Generation Projects			
Number of Generation Projects Participated in			
Number of Countries in which you participated in a Generation Project			
Organization's Role in Saudi Generation Projects			
Educational Qualifications			
Name of School/College/University/Institution	**Year Attended**		**Qualification**
	From	**To**	Certificate/Diploma/Degree