Ain Shams University
Faculty of Engineering
Department of Structural Engineering

Risk Assessment in the Construction of Potable Water Treatment Plants in Egypt

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science In Civil Engineering

(Structural Engineering)

By

Ahmed Mostafa Awad

Bachelor of Science In Civil Engineering

(Structural Engineering)

Faculty of Engineering, El Shorouk Academy, 2008

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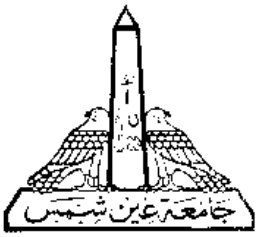

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ABSTRACT

Life is connected through drinking water as it the most essential aspect of life, even though it though it also represent one of the highest risk for humankind (Water, 2019). Egypt is a part of the world and its population increases every day therefore it is also subject to that risk. According to the Central Agency for Public Mobilization and Statistics, drinking water in Egypt per capita fell from 88.9 m3 in 2013 to 76.9 m3 in 2014 representing 13.5% making drinking water one of Egypt's problems in the coming period. Which prompted the Egyptian government to allocate 35% from the total Egyptian government plan to develop potable and wastewater systems in 2015 (4.44 billion Egyptian pounds), equivalent to 1.5 billion Egyptian pounds. Because of the dedication of the Egyptian government represented in the ministry of housing to solve that problem, the result is the rate per capita increased by 45% from 76.9 m3/year 2014 to 112.1 m3/year 2018. The total production also increased by 38% from 7.8 billion m3/year in 2014 to 10.8 billion m3/year in 2018 (CAPMAS, n.d.). The Egyptian government represented in the ministry of housing still invest in the construction of many potable water plants to eradicate of the potable water problems. This type of projects has significant importance due to the strategic impact, big budget, tight schedules, and a lot more obstacles. As the potable water treatment plant, bear a large number of risks, which make this project one of the riskiest projects in the construction business. Two techniques were utilized literature review and meeting with professionals in the construction of this type of projects to identify and verify 56 risk factors. A questionnaire was developed to obtain a professional opinion of the impact and probability of the previously identified risk and its proper response plan. The Risk factor of each risk is calculated using (P+C-(P×C)) formula. A priority list developed to identify the most significant risks. The most significant risks include Fluctuation in the currency exchange rate, delay in contractor payments to sub-contractors, tight schedule and crowding, late delivery of materials, delay in progress payments, inflation, change in energy cost. Internal project risks are slightly more important than external risks. A recommended risk strategy is presented to help contractors in selecting the appropriate approach to respond to any risk of the identified risks in this research, all of this based on the collected data. This research directed to the concerned parties of this type of projects (project manager, sponsors, etc.) to help to better prepare a proper risk plan and their mitigation strategy plan at the start of the project.

Keywords Project Management, Risk Management, Potable Water Treatment Plants, Planning & Control, and Infrastructure.

Chapter (1)

Introduction

1.1 Introduction

The construction sector is counted as one of the most active sectors affecting the Egyptian economy to the extent that about 45% of the funds allocated for the national development plans in Egypt since 1981 were allocated to the construction sector (Ahmed, 2003)**[6]**. Many projects constructed annually to meet the needs of Egyptian society such as bridges, tunnels, highways, roads, sewer systems, and water supply facilities (Ismail, 1999)**[33]**. Water treatment plants are classified as infrastructure projects that are usually administrated by public authorities. Such class of projects is critical and has different components including buildings, underground piping, and equipment. In recent decades, Egypt witnessed the construction of many water treatment plants (Mohamed Marzouk, 2015)**[46]**.

The primary goal of every construction project is to meet stakeholder`s functional requirements. It has been noted that quite often, construction projects fail to achieve their objectives (time and budget). This is frequently because of the failure of the contractor to analyze and assess seen and unforeseen risks.

Currently, many construction firms are seeking to identify and develop techniques for measuring the risks associated with construction projects, due to the increasingly competitive market. All construction projects are related to different levels of risk, regarding cost and duration depending on project complexity, resources, market prices, location, and many other challenging factors (Hassan, 2004)**[30]**.

In the practice of construction risk management, (Perry, J.G. and Hayes, 1985)**[50]** stated characteristics of construction risk as risks and uncertainties are associated with specific events or activities that can be individually identified. A wide range of results materializes when a risk event happens each result has its likelihood of happening.

- Some risks offer only the prospect of adverse consequence (loss) as bankruptcy, war, sea or flood damage; these may be of low or high probability but high impact.
- Many common construction risks offer the prospect of either loss or gain as productivity of labor and plant; these are typical of high probability and may be of low or high impact.
- Subjective judgment is usually required to calculate the probability of occurrence of specific outcomes of the risk event.

1.2 Problem Statement

The construction industry faces a lot of obstacles those are multiplied in the past few years due to the circumstances of the state and because most of the contractors in the industry were not ready to face those risks. The risk management technique was not hugely adopted with the majority of the participants in the industry, which lead to a catastrophic effect on the contractors against these huge no number of unforeseen risks, which was raised in the past few years.

According to the central agency for public mobilization and statistics, the Egyptian government spends approximately 4.44 billion Egyptian pounds in the water systems and sewer systems [financial year of 2014/2015] 35% (1.5 billion Egyptian pounds) of this sum is spent on the water treatment plants. The potable water treatment plants have a significant importance due to the strategic importance, big budget, tight schedules, and a lot more obstacles, As the potable water treatment plant bear large number of risks which make it one of the riskiest project in the construction business and for a contractor to enter that kind of projects without a proper risk and risk response plan will only lead the contractor to an inevitable loss.

Therefore, a thorough study must focus on the risks and the risk responses in the potable water treatment construction project and try to come out with a framework for managing risks in the potable water treatment plant construction project to help contractors in selecting the appropriate strategy to manage the risks and uncertainties and devolve a risk response plan to counter these risks.

1.3 Research Main Objective.

These research main goals are to:

1- Specify the most significant risk factors related to the construction of the potable water treatment plant projects in Egypt and perform a qualitative risk assessment for such factors.

2- Identify the risk response strategies during the project life cycle.

3- Develop risk expert application (automated risk management system [A.R.M.S.]) using WordPress as web-based software to generate a web application to help contractors in selecting the appropriate strategy to respond to any risk all of this based the collected data.

1.4 Scope of Research

The range of this research includes a complete project risk management cycle (negative risks) for potable water treatment plant projects in Egypt whether constructing new plant or rehabilitation and enhancing existing plant and their associated response methods in the project life cycle. In addition, an expert web application model is developed to help contractors in this field.

1.5 Methodology

1- A Literature review will be carried out to identify a list of risk factors, which could affect the potable water treatment plant construction projects.

2- Several meetings with professionals in these types of projects will be done to verify the aforementioned list.

3- Based on this literature review a survey will be conducted with experts in the construction of potable water treatment plant projects to evaluate the list of the significant risk regarding (probability & impact).

4- Following data collection, the data will be analyzed statistically to determine the most critical factors in potable water treatment plant construction projects.

5- Identify the response actions and strategies that could be employed to mitigate the effect of the identified risks.

6- Develop a risk expert application model [A.R.M.S.]

Chapter (2)

Literature Review

2.1 Introduction

A huge number of risks faces the construction industry as the construction projects contain a great number of risks in its process because of the involvement of a considerable number of participants such as (owner-contractor etc.) (El-Sayegh, 2008)**[22]**. The success parameter of any project is to accomplish the project with proper (scope, time, budget and quality) that can be achieved through decision-making process which depends on two important parameters analysis and management of risk. Construction projects frequently fail to meet their time, quality and budget goals. One of the main reasons behind this is the failure of the contractor to analyze and assess project risks. The divergence in the environment of the project is considered the primary obstacle in the success of the project to meet its objectives.

The problem increases with the magnitude and nature of the construction project. The amount of risks in the internal and external environments of a project is a critical factor in deciding whether there will be scheduled and cost overruns. Thus, The frequency of increase in budget and schedule of construction project made the risk in construction a primary subject of interest. Risk management is the key tool in construction project management as it defines the needs for every aspect in project management technique example (schedule is done to avoid time overruns, etc.) Therefore, the most important process in project management is managing the risk

2.2 RISK

2.2.1 Risk Definitions

Defining the terms "Risk" and "Uncertainty."

Risk can be defined in different ways. (Project Management Institute (PMI)., 2013)**[53]**. Defined risk as when one or more objective of the projects such as scope budget schedule and quality is subjected to a negative or positive divergence due to the defined or undefined event. (Creedy, G., Skitmore, M., and Wong, 2010)**[18]** Defined risk as an external factor if happens to a pre-planned (situation or circumstances) change a certain progression of planned events resulting in impacts