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Determination of the Contingency Values for the Construction of Water Treatment Plant Projects in Egypt

BY

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B.Sc Civil Engineering

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A Thesis

Submitted in Partial Fulfillment for the Requirements of the Degree of Master of Science in Structural Engineering

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STATEMENT

This thesis is submitted as a partial fulfillment of Master of Science in Civil Engineering Engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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ABSTRACT

All phases of construction projects include many risks. Those risks lead to serious cost escalation where Water Treatment Plant projects are not an exception. The Egyptian government spent around 4.44 billion Egyptian pounds on the water and sewer systems in 2014. The amount spent on Water Treatment Plants was around 35% of this sum (1.5 billion Egyptian). Water Treatment Plant Projects have significant importance due to their huge budget, tight schedules and obstacles. This leads to high level of risks in these projects. Therefore, the purpose of cost Contingency is to generate a reserve fund that is adequate to cover the ingrained risks in the project's total budget and completion duration. Its presence removes the negative impact of unforeseen event.

The issue of setting appropriate Contingency is one that often poses difficulties for most Water Treatment Plant Projects as a vital constituent of a project budget is "Cost Contingency". Generally, a Contingency is represented as a fixed percentage of project cost. However, it is not appropriate to apply this deterministic method to Water Treatment Plants projects due to its huge variability. This variability makes every Water Treatment Plant a unique one of a type Project.

Developing an artificial neural network (ANN) model that can help contractors, during the tendering stage, to predict the Contingency percentage was the main purpose of the study. An ANN model was constructed, using MATLAB Neural Network Toolbox, to predict the contractor's Contingency. This model has been trained, tested and validated with real data gathered from more than 80 constructed Water Treatment Plants. The sampling data was divided into three categories; 60% of the total input data was used for training the model, 20%

for testing the model and 20% for validating the model. The performance graphs for various training algorithm, error plots between trial test and ANN anticipated values for Contingency percentage, comparison graphs for training, testing and validation (regression plots) have been discussed based on coefficient of correlation, R. The results demonstrate a decent understanding between the actual and ANN anticipated results which strongly support the development of such models for Contingency estimation of Water Treatment Plants projects. The model can be further simulated to assess contractors in Contingency estimation for novice data and provide them with more realistic results than the mere deterministic method.

Keywords: Artificial Neural Network, Backpropagation Neural Networks, Coefficient of Correlation, Contingency, Deterministic methods, Probabilistic methods and Neurons.

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1 Introduction

1.1 General

"All human activities have ingrained risks especially construction work(s) which contain various risk elements" (Oladapo, 2006). Some of the difficulties during Construction are the risks and uncertainties. The risk's degree is different for every project. No construction project can be done without having elements of risks within it (Kwakye, 1997).

The construction industry defines risk as being subjected to loss or gain resulting from the construction process (Oladapo, 2006). Physical risk, environmental risk, political risk, legal risks and financial risk, are some of the major risks in construction projects (Oladapo, 2006). Recently, due to time and cost overruns, the risk in construction has garnered attention.

There are different risk response strategies for each type of risk. The plan for managing the identified risks is called the Risk Response Plan. There are four major risk responses categories (Project Management Institute, 2004) which are;

- Mitigation strategies involve reducing the probability of the risk or its impact.
- Avoidance strategies aim to avoid the risk completely. Sometimes, this requires having a new structure for the project.
- Transfer strategies where the risk is transferred to another entity. Lump sum is an example of transferring all risk to the contractor even if this leads to higher price for the owner.
- Acceptance strategies require knowing the risks, their probability and impact and finding way to provide room for those risks.

A typical Risk Plan includes all types of risk responses. At the

beginning of projects, risk avoidance should be applied to techniques that require demolition. Risk mitigation for poor workmanship can be solved by choosing qualified bidders. Risk transfer for contract prices' fluctuations by having a fixed contract type. Finally, the remaining unknown risks must be accepted.

For the accepted risks, it is crucial to get rid of most unknown risks through the identification process. Consequently, a Contingency reserve of time or budget can be assigned to those risks that have the greatest effect on duration and cost.

The issue of setting appropriate Contingency is one that often poses difficulties for most Water Treatment Plant Projects because the cost Contingency is a very important aspect in project budget. Cost Contingency for projects has been part of the project management process for more than 5 decades. Regardless of the omnipresence of project cost Contingency in cost management, there has been little research for the estimation methods of Contingency. The accurate estimate of Contingency directly affects the project's cost (Baccarini D. , 2005).

The purpose of cost Contingency is to create a reserve fund that is adequate to cover the ingrained risks in the total budget and the completion duration.

One of the key success criterions for project owners is the cost performance for all the different types of the Construction Projects. Cost Contingency is usually included within the estimated budget that will be presented to the project sponsor. Contractors usually never accurately calculate the cost Contingency; they subjectively estimate it as 5‑10% from the total cost estimated; their basis for estimation depends solely on their experience in past similar projects. However, this method does not have a sound basis and is

difficult to justify or defend. Therefore, cost Contingency estimation is of a great importance to projects.

1.2 Research Objective and Scope

This research work investigates the determination of Contingency values for Water Treatment Plant projects in Egypt. The study's scope can be summed up as follows:

1. Study of Water Treatment plant projects model.
2. Explore and assess the initial list of variables that influence Contingency cost estimation for Water Treatment plant projects. This can be done through referring to previous literature findings and conducting experts' interviews. Also, determine the output variable form as the application objectives of the ANN model.
3. Determine the form of the output variables as the application objectives of the artificial neural network (ANN) model.
4. Build a model for future use to help the contractors, before the tendering stage, to determine the cost contingency reserve for similar Water Treatment plant projects.

1.3 Thesis Organization

The five chapters of this thesis are presented hereinbelow;

Chapter (1) Introduction: introduces the research topic, the objective of this research and the thesis outline.

Chapter (2) Literature Review: includes a literature review on cost Contingency estimation methods.

Chapter (3) Research Approach and Methodology illustrates the research approach and methodology followed in this study. This study is to be conducted in five main steps; Strategizing (exploring variables), data collection and evaluation, ANN model development using Neural Network toolbox, mode