



AIN SHAMS UNIVERSITY  
FACULTY OF ENGINEERING  
STRUCTURAL DEPARTMENT

**EXPERT SYSTEM DEVELOPMENT FOR EVALUATING COMPETITION ABILITY  
OF EGYPTIAN CONSTRUCTION COMPANIES IN INFRASTRUCTURE PROJECTS**

A thesis Submitted in partial fulfillment of the requirement for the Degree of Doctor of Philosophy  
In Structural Engineering

*By*

**Eng. / Ahmed Afify Mostafa Elsaid**

M. Sc. Civil Engineering, 2005  
Faculty of Engineering- Shoubra . Benha University

*Supervised by*

**Prof. Dr. / Ibrahim Abd El Rashied Nosair**

Professor of construction Management  
Faculty of Engineering. Ain shames University

**Prof. Dr. / Manal Sayed Abd El Hamid Aly**

Director of Construction and Project Management Institute.  
Housing and Building National Research Center

**Cairo-2018**





AIN SHAMS UNIVERSITY  
FACULTY OF ENGINEERING

**EXPERT SYSTEM DEVELOPMENT FOR EVALUATING COMPETITION ABILITY  
OF EGYPTIAN CONSTRUCTION COMPANIES IN INFRASTRUCTURE PROJECTS**

*By*

**Eng. Ahmed Afify Mostafa Elsaid**

M. Sc. Civil Engineering, 2005  
Faculty of Engineering- Shoubra. Benha University

**EXAMINERS COMMITTEE**

**Name**

**Signature**

**Prof. Dr. Sami Mohammed fereig**  
Professor of construction Management  
Waterloo University

**Prof. Dr. Adel Abo Elyazid El Samadoni**  
Professor of construction Management  
Faculty of Engineering- Helwan University

**Prof. Dr. Ibrahim Abd El Rashied Nosair**  
Professor of construction Management  
Faculty of Engineering- Ain shames University

**Prof. Dr. Manal Sayed Abd El Hamid Aly**  
Director of Construction and Project Management Institute.  
Housing and Building National Research Center

**Date : / / 2018**



### **Researcher Data**

Name : Ahmed Afify Mostafa Elsaid

Date of birth : 20-11-1969

Place of Birth : Shoubra – Cairo -Egypt

Academic Degree : Master

Field of specialization : Civil Engineering

University issued the degree : Benha University

Date of issued degree : 2005

Current Job : *Lecturer Assistant*, Housing and Building National  
Research Center



## **STATEMENT**

This thesis is submitted as partial fulfillment of PHD degree in structural 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 qualification at any other scientific entity.

Signature

Student name



## Thesis Summary

The Egyptian construction companies that work on infrastructure projects are facing increasing challenges due to the increasing competition from foreign contractors. These challenges urge the need for evaluation of the competition ability of Egyptian construction companies. Reviewing the literature it was found that there are thirteen criteria must be taken into consideration when evaluating the competition ability (i) Financial ;(ii) Health and Safety ;(iii) Technical; ;(iv) Quality;(v) Organization ;(vi) Relationship ;(vii) Past Experience ;(viii) Past Performance ;(ix) Resources ;(x) Environmental ;(xi) Management ; (xii) Present workload ;( xiii) Tendering price. The thirteen criteria have twenty seven sub-criteria that are collected from previous studies that influence the competition ability. This research identifies the most important sub criteria such as the Size of past project completed, Type of past project completed, Adequacy of labour resources, QA/QC programs, Adequacy of plant & equipment's ,Present workload, Construction program, Construction method and Environmental plan. The data applied in this study are collected through a survey distributed to 23 experts in construction industry to determine the weight of each sub criteria, statistical analysis is carried out on respondents of the survey. By using SPSS software the mean score of each sub criteria and standard deviation were determined. Then a Framework for contractor selection was developed to evaluate and rank the bidders in infrastructure tenders based on sub criteria weights. The research also developed an expert system that can be used to evaluate the bidders and rank them in the Egyptian infrastructure projects tenders. Three cases study have been provided to check the validity of the proposed system and the result was the same as tender committee decision. Also the expert system have been examined by gathering the opinions of ten tender experts through personal interviews with a written questionnaire. The results showed that the proposed expert system practical and can be implemented. Finally, the developed expert program facilitates contractor selection instead of human judgment.

### Keywords

Competition, Construction, Infrastructure, Egypt, Criteria, Companies, Expert system.



## **ACKNOWLEDGMENT**

I wish to express my sincere gratitude to my supervisor Prof. Dr. Ibrahim Abd El Rashied Nosair Professor of Construction Management; Ain Shams University for his valuable advice and guidance assistance over the years and throughout the work on this thesis and Prof. Dr. Manal Sayed Abd El Hamid Aly Director of Construction and Project Management Institute; Housing and Building National Research Center who gave me her help on comments, for preparation my thesis and general matters relating to thesis. I am also grateful to those people who provided me with information for preparing this thesis.

Finally, I would like to thank my wife, my sons Omar, yousef and my daughters Sarah and Farah, my parents, my family and my friends for their constant support and encouragement.



## TABLE OF CONTENTS

	<b>Page</b>
<b>ABSTRACT</b>	<b>i</b>
<b>ACKNOWLEDGEMENTS</b>	<b>ii</b>
<b>LIST OF FIGURES</b>	<b>vii</b>
<b>LIST OF TABLES</b>	<b>ix</b>
<b>LIST OF APPREVIATIONS</b>	<b>xi</b>
<b>CHAPTER (1): INTRODUCTION</b>	
<b>1.1 Overview .....</b>	<b>2</b>
<b>1.2: Motivation for Research .....</b>	<b>2</b>
<b>1.3: Research Objectives .....</b>	<b>3</b>
<b>1.4: Research Methodology.....</b>	<b>4</b>
<b>1.5: Reader's Guide .....</b>	<b>5</b>
<b>CHAPTER (2): LITERATURE REVIEW</b>	
<b>2.1: Introduction .....</b>	<b>8</b>
<b>2.2: Concepts and Definitions .....</b>	<b>8</b>
<b>2.2.1: Prequalification .....</b>	<b>8</b>
<b>2.3: Contractor Evaluation .....</b>	<b>10</b>
<b>2.3.1: Financial Evaluation .....</b>	<b>10</b>
<b>2.3.2: Technical Evaluation .....</b>	<b>10</b>
<b>2.4 Contractor selection criteria .....</b>	<b>11</b>
<b>2.5: Methods of contactor selection.....</b>	<b>14</b>
<b>2.5.1: Single Criteria (Bid Price).....</b>	<b>14</b>
<b>2.5.2: Multi- Criteria .....</b>	<b>14</b>
<b>2.5.3: Analytical Hierarchy Process .....</b>	<b>15</b>
<b>2.5.4: Analytical Network Process (ANP) .....</b>	<b>15</b>
<b>2.5.5: Multi-Attribute Utility Theory.....</b>	<b>16</b>
<b>2.5.6: Fuzzy Set Theory (FST) .....</b>	<b>16</b>
<b>2.6: Artificial Intelligence and Expert System.....</b>	<b>17</b>

2.6.1: Advantage and Disadvantage of Expert System.....	17
2.6.2: Guidelines for Knowledge-Base Development.....	18
2.6.2.1: Identify all Relevant Resources of Knowledge.....	19
2.6.2.2: Structure all Knowledge Acquisition Activities.....	19
2.6.2.3: Extract Knowledge from Resources.....	19
2.6.2.4: Evaluate Quality of Knowledge Base.....	19
2.6.2.5: Complete Development of Prototype Expert System.....	20
2.6.3: Applications of Expert Systems in Construction Management.....	20
2.6.3.1: Construction Site Management.....	21
2.8.3.2 : Contract Management.....	22
2.8.3.3 : Construction Planning, Scheduling and Control.....	23
2.7: Summary.....	24
<b>CHAPTER (3): FIELD SURVEY AND DATA ANALYSIS</b>	
3.1: Introduction.....	26
3.2: Current Evaluation Criteria .....	26
3.2.1: Hatush and Skitmore (1996) Evaluation Criteria .....	26
3.2.2: EL-Kashif (2000) Evaluation Criteria .....	28
3.2.3: Alotaibi (2011) Evaluation Criteria .....	31
3.3: The Proposed Evaluation Criteria .....	33
3.4: Methodology.....	34
3.5: Questionnaire Design .....	34
3.5.1: Sample Size.....	35
3.5.2: Sample Profile.....	36
3.6: Data analysis.....	36
3.6.1: Competition ability criteria weights.....	36
3.6.2: Calculation of sub criteria mean score.....	38
3.6.2.1: Financial of contractor.....	39
3.6.2.2: Health and safety of contractor.....	39
3.6.2.3: Technical of contractor.....	40
3.6.2.4: Quality of contractor.....	41

<b>3.6.2.5: Organization of contractor.....</b>	<b>41</b>
<b>3.6.2.6: Relationship of contractor.....</b>	<b>42</b>
<b>3.6.2.7: Past experience of contractor.....</b>	<b>42</b>
<b>3.6.2.6: Past performance of contractor.....</b>	<b>43</b>
<b>3.6.2.9: Resources of contractor.....</b>	<b>44</b>
<b>3.6.2.10: Management of contractor.....</b>	<b>44</b>
<b>3.6.3: Calculation of sub criteria Relative weight.....</b>	<b>45</b>
<b>3.7: Framework for contractor selection.....</b>	<b>47</b>
<b>3.8: Summary.....</b>	<b>54</b>
 <b>CHAPTER (4): SYSTEM DEVELOPMENT</b>	
<b>4.1: Introduction.....</b>	<b>56</b>
<b>4.2: System Components.....</b>	<b>56</b>
<b>4.4: Building ES-TE.....</b>	<b>57</b>
<b>4.5: ES-TE User Interfaces.....</b>	<b>58</b>
<b>4.5.1: Information and Project Data.....</b>	<b>58</b>
<b>4.5.2: Contractor selection Attributes.....</b>	<b>60</b>
<b>4.5.2.1: Financial aspects.....</b>	<b>62</b>
<b>4.5.2.2 : Health and safety.....</b>	<b>63</b>
<b>4.5.2.3: Technical aspects .....</b>	<b>64</b>
<b>4.5.2.4: Quality .....</b>	<b>65</b>
<b>4.5.2.5 : Organization .....</b>	<b>66</b>
<b>4.5.2.6 : Relationship .....</b>	<b>67</b>
<b>4.5.2.7 : Past Experience.....</b>	<b>68</b>
<b>4.5.2.8 : Past Performance.....</b>	<b>69</b>
<b>4.5.2.9: Resources .....</b>	<b>70</b>
<b>4.5.2.10: Environmental Aspects.....</b>	<b>71</b>
<b>4.5.2.11: Management.....</b>	<b>72</b>
<b>4.5.2.12: Present Workload.....</b>	<b>73</b>