

**A FRAMEWORK FOR COST ASSESSMENT OF QMS FOR BUILDING  
CONTRACTORS  
BASED ON BIOLOGICAL IMMUNE SYSTEM**

**ALI KEYVANFAR**

**A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR  
THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (CONSTRUCTION MANAGEMENT)**

**FACULTY OF CIVIL ENGINEERING  
UNIVERSITI TEKNOLOGI MALAYSIA**

**JUNE, 2009**

*To those how teach me since I was born*

## ACKNOWLEDGEMENT

With the saying thanks to “ALLAH” for getting me the opportunity to do this project, I would like to give my sincere appreciation to my project supervisor Assoc. Prof. Dr. Abdul Kadir Bin Marsono for being patience with me, and his friendly guidance, critic advices, motivation and last not least the valuable encouragement.

While preparing this project, I was in contact with many academicians’ student and lecturers from Faculty of Civil Engineering, Built Environment, Geo-information and Computer Science, besides construction professionals in construction firm, consultants. They have contributed towards my understanding and thoughts. In particular, I am also very thankful to all of them for their willingness to share their valuable knowledge, expertise and technical know-how which assist me a lot in preparing this project. Without their continued support and interest, this project would not have been the same as presented here.

I cannot forget my lovely mother and father for all which I have. Besides, I am also would like to thank all the lecturers who have conducted the course from the beginning of this master program and not hesitating to share their knowledge with us. My fellow postgraduate students should also be recognized for their support. My sincere appreciation also extends to all my classmates Farahbod, and his wife, Masoumeh, Tey, Poorya, Mohsen, Fazil, Seiiid Ali, Hamed, Azwan and others which unfortunately, it is not possible to list all of them in this limited space, which have provided individually and sometime group assistance at various occasions.

Finally, I want to give my special thanks to my panels Dr. Amina, Dr. Khairulzan, Dr. Rozana, for their kindly advises.

## **ABSTRACT**

Quality as a traditional objective in construction industry that is lacking of quantitative assessment approach has been planned and evaluated in qualitative manner. Study in order to develop a feasible quantitative QMS (Quality Management System) assessment framework, has been considered Cost of Quality as a quantitative measurement to evaluate the success of quality program in a self-improvement organization. Therefore, in this study, elements of cost of quality in several approaches have been reviewed. Besides, principles of several QMS tools and techniques: Taguchi methods, process of Failure Mode and Effect Design (FMEA), Benchmarking techniques, Shainin, Demings 14 point for Plan for TQM, Six-Sigma and finally Kaizen management philosophy are reviewed. Furthermore, objectives of Biological Immune System (BIS) to capture the success factors of an intelligent system have been reviewed. Through this study, proposed intelligent based framework model and its tools and descriptions have been developed. For evaluating finding objectives, each finding has been discussed with relevant field of research experts. Finally feasible validations were made by questionnaires on 5 industrial experts.

## ABSTRACT

*Kuanliti adalah objektif tradisional di industri pembinaan di mana kekurangan pendekatan tentang penilaian kuantitatif dirancang and ditimbangkan dengan cara kualitatif. Penyelidikan ini adalah untuk mengembangkan satu rangka penilaian kuantitatif QMS yang fleksibel dengan dipertimbangkan kualiti kos sebagai penilaian kuantitatif menilaikan kejayaan bagi program kualiti di organisasi kemajuan diri. Oleh demikian, elemen-elemen bagi kualiti kos di beberapa pendekatan akan dikaji semula di penyelidikan ini. Prinsip-prinsip bagi peralatan dan teknik QMS adalah seperti berikut: Taguchi methods, process of Failure Mode and Effect Design (FMEA), Benchmarking techniques, Shainin, Demings 14 point for Plan for TQM, Six-Sigma and finally Kaizen management philosophy” akan dikaji semula. Selain itu, objektif bagi Biological Immune System (BIS) yang sebagai sistem kecerdasan untuk merangsangkan satu kecerdasan model organisasi akan dikaji semula. Daripada penyelidikan ini, cadangan kecerdasan bagi rangka model, peralatan dan deskriptif akan dikembangkan. Untuk mencapai objektif, setiap keputusan akan dibincangkan dengan medan pakar penyelidik. Akhirnya, pengesahan fleksibel akan dilaksanakan melalui penyediaan soal selidik kepada 5 pakar industri.*

## CONTENTS

<b>CHAPTER</b>	<b>PAGE</b>
TITLE PAGE.....	1
SUPERVISOR DECLARATION .....	2
DECLARATION.....	3
DEDICATE.....	4
ACKNOWLEDGEMENT.....	5
ABSTRACT .....	6
ABSTRAK .....	7
CONTENTS .....	8
LIST OF FIGURE .....	12
LIST OF TABLE .....	13
REFERENCES.....	94
APPENDIX I .....	96
APPENDIX II.....	115
<b>CHAPTER I                    INTRODUCTION</b>	
1.1    Problem Background.....	14
1.2    Problem Statement.....	16
1.3    Aim .....	16
1.4    Objectives.....	17
1.5    Scope.....	17
<b>CHAPTER II                    LITERATURE REVIEW</b>	
2.1    Definitions .....	19
2.2    Quality cost measurement approaches .....	21
2.2.1    Davis Approach (1987) .....	22

2.2.2	Abdul-Rahman's approach (1993)	22
2.2.3	Low and Yeo's approach (1998)	23
2.2.4	Barber et al. (2000)	23
2.2.5	Love and Li (2000)	23
2.2.6	Aoieong et al. (2002)	24
2.2.7	Love and Irani (2003)	24
2.3	Quality engineering methodologies	25
2.3.1	Taguchi methods	25
2.3.2	FMEA	26
2.3.3	Benchmarking	26
2.3.4	Shainin	26
2.3.4.1	The Guiding Principles of the Shainin System TM (SS)	27
2.3.4.2	Dominant Causes of Variation Progressive Search	28
2.3.4.3	Multivari	29
2.3.5	Deming's 14 Point Plan for TQM [12,8]	29
2.3.6	Six-Sigma [12]	34
2.3.6.1	Six-Sigma for Best Quality Delivery	35
2.3.6.2	Six-Sigma Methodology [12]	37
2.3.6.3	Six-Sigma in Construction Industry [12]	37
2.3.7	Kaizen Management Philosophy	39
2.3.7.1	Development of Kaizen	40
2.3.7.2	Benefits of Kaizen	41
2.3.7.3	Principles of Kaizen	42
2.3.7.4	Tools of Kaizen	43
2.3.7.5	Basic tips for kaizen activities [11]	43
2.4	Artificial intelligent system	44
2.4.1	Immune Systems	45
2.4.2	The Biological Immune System	45
2.4.2.1	Pattern Recognition Capability	50
2.4.2.2	Learning Capability	50
2.4.2.3	Information Storage Capability	50
2.4.3	Artificial Immune System	51
2.4.3.1	Origins of Artificial Immune System	53
2.4.3.2	The Immune System Training	53

2.4.3.3	Elements of Artificial Immune Systems.....	54
2.4.3.4	Use of Memory in Artificial Immune System.....	55
2.4.3.5	Antigens and Antibodies .....	56
2.4.3.6	Affinity Measures.....	57
2.4.3.7	The Negative Selection Model.....	57
2.5	Quality Metrics Of Information Systems.....	59

### CHAPTER III RESEARCH METHODOLOGY

3.1	Introduction.....	61
3.2	Method of data collection .....	61
3.3	Data collection .....	62
3.4	Data analysis.....	62
3.4	Validation.....	63

### CHAPTER IV RESEARCH FINDING

4.0	Introduction.....	65
4.1	Success factors of BIS to simulate for assessment of QMS tools .....	65
4.2	Proposed model for assessment and in process improving of QMS tools based on cost of quality.....	70
4.2.1	Proposed tools for assessment of quality program.....	74
4.2.2	Explanation of columns of Tables 4 and 5 .....	75
4.2.3	Explanation of elements of column 1.....	77
4.2.4	Explanation of elements of columns 2, 3, 4 and 5.....	82
4.2.5	Explanation of analyzing of elements of columns .....	83

### CHAPTER V VALIDATION

5.1	Validation.....	86
5.2	Introduction to Conclusion.....	88
5.2.1	Finding of the objective.....	88



<b>5.2.2</b>	<b>Future works</b> .....	<b>93</b>
<b>5.2.3</b>	<b>Conclusion</b> .....	<b>94</b>

## LIST OF FIGURE

FIGURES	TITLE	PAGE
	<b>Figure 1: A conceptual model for benchmarking the interfaces of the quality chain. (P.E.D. Love and J. Smith (1998))</b>	15
	<b>Figure 2: The Shainin system for quality improvement (Shainin 1992)</b>	27
	<b>Figure 3: Graph of the normal distribution [12]</b>	35
	<b>Figure 4: The PDCA cycles (Deming 1986)</b>	43
	<b>Figure 5: Adopted from Jon Timmes 2009</b>	46
	<b>Figure 6: Research methodology sequences</b>	64
	<b>Figure 7: Adopted from Abdul Hakim Mohammed et al 1998</b>	71
	<b>Figure 8: Intelligent organizational model of self-assessment and self improvement of Quality program</b>	73
	<b>Figure 9: TQM implementation process (Johnson Tan Swan San 2000)</b>	75
	<b>Figure 10: Comparison of planed S carve for planed cumulated defect cost and actual defect cost and typical plan</b>	83
	<b>Figure 11: An example to show flow of framework</b>	92

## LIST OF TABLE

TABLES	TITLE	PAGE
	<b>Table 1: Categorisation of quality-related costs (Feigenbaum 1961; Crosby 1979; Juran and Gryna 1993).....</b>	<b>21</b>
	<b>Table 2: Comparison of process and result based focus of organization or customer(Zora Arsovski, Slavko Arsovski 2007).....</b>	<b>60</b>
	<b>Table 4: Activity/timely based check list for capturing COQ (Managerial cost) .....</b>	<b>76</b>
	<b>Table 5: Activity/timely based check list for capturing COQ (Implemented cost) .....</b>	<b>77</b>
	<b>Table 6: Rework classification system (Burati et al 1992).....</b>	<b>80</b>
	<b>Table 7: Analysis sheet for each element columns 1 and 2.....</b>	<b>85</b>
	<b>Table 8: Analysis sheet for each element columns 3, 4 and 5.....</b>	<b>85</b>
	<b>Table 9: QMS improvement tools principles to reduce cost of Quality related to PAFF model.....</b>	<b>87</b>

## **CHAPTER I**

### **INTRODUCTION**

#### **1.1 Problem Background**

In construction industry, it is common to evaluate project performance by comparing only actual cost and time with scheduled cost and time. In order to assess quantitatively process performance of quality program and also even to improve quality program, the problem was having quantitative “measurement”, until recently quality has been measured by quantitative measurement and named Cost of Quality (COQ). But it has not been used in monitoring and controlling manner for assessing the current quality program of project, instead, it is used only to predict for reducing the future projects cost of quality. P.E.D. Love and J. Smith (1998) tried to bring quality to account through recording cost of quality to predict future performance with presents of different policies and various methodologies [2], [15] as shown in Figure (1). Davis (1987); Abdul-Rahman (1993); Low and Yeo (1998); Barber et al (2000).; Love and Li(2000); P.E.D. Love, Z. Irani (2003) and a few others,[1] also tried to introduce information systems to capture cost of quality.

This study tried to perform an intelligent organizational model, for quantitative assessment (based on cost of quality) and self improvement framework for quality program in building construction in contractor sector.

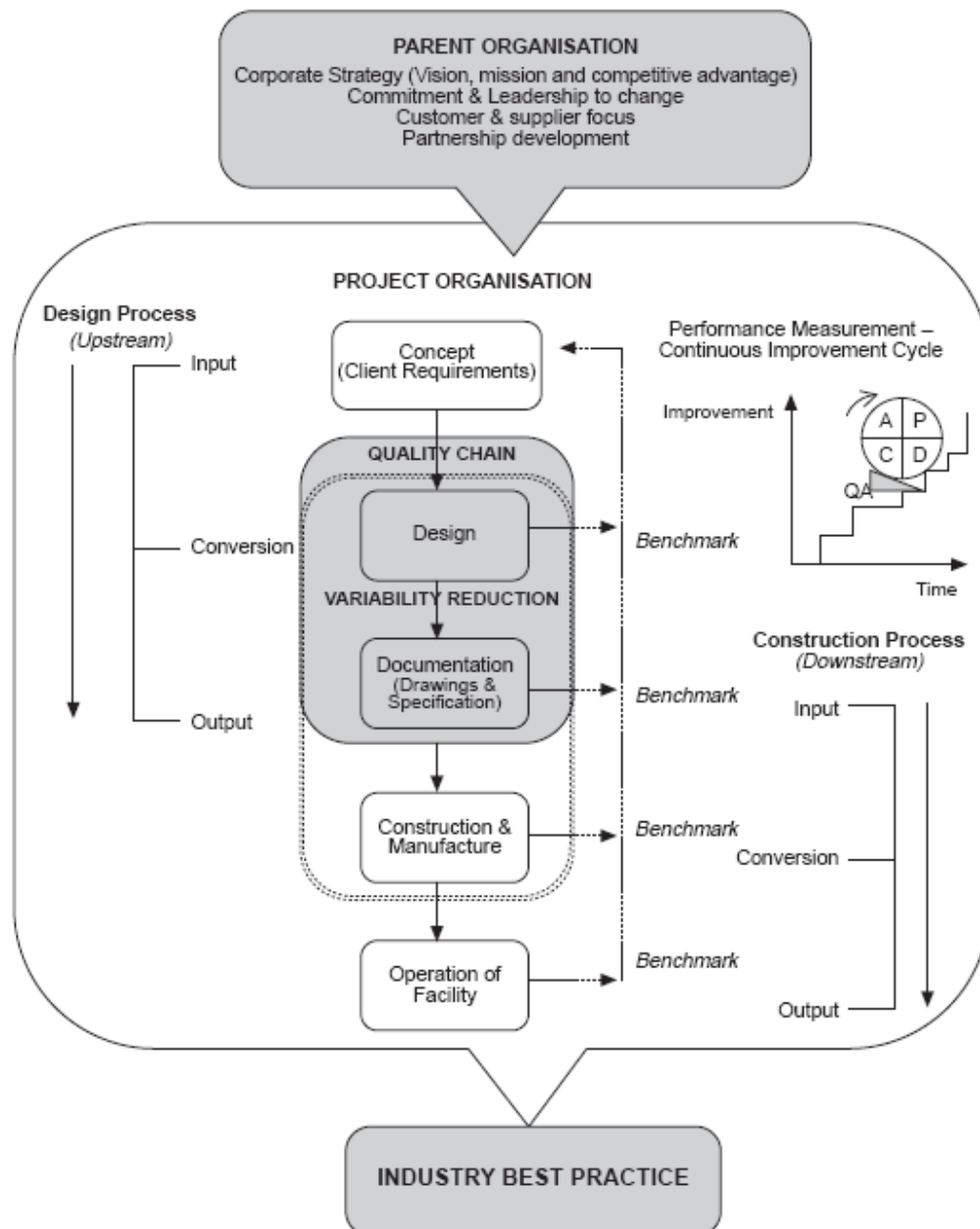


Figure 1: A conceptual model for benchmarking the interfaces of the quality chain. (P.E.D. Love and J. Smith (1998))

## **1.2 Problem Statement**

Referring to ISO TR 15504 as a process improvement principle, beside the fast growths of construction project complexity especially in terms of quality, it is necessary to implement self quality assessment system for QMS tools as a technique to analyse the quality plan of construction projects for catching better quality performance. In this manner it can implement by defining job description, rather than job specifications which act as policies. In other words, in order to have self improvement QMS system as a key performance indicator, it is subjected to lead quality of construction, even QMS tools, by itself. It will also to use project descriptions rather than project specification and finally to use task oriented assessment system rather than skill oriented.

## **1.3 Aim**

The study is carry out in order to solve the stated problems based on cost value of quality, by continues assessment and improvement of the quality plan, in construction project has been studied. Therefore, in order to cover the overall aim of study, this effort goes to the development of one framework (IDEF4 (Integration DEFinition) semi-structured based) model and tools. It is focusing on contractor's party for in process assessing and self-improvement framework to improve the implemented QMS tools and techniques in collaborative environment to construct building projects. It will be assumed as bases for internal benchmarking quality assessment system which referred to cost of quality for health check of quality assurance performance.

## 1.4 Objectives

Therefore, for achieving overall aim of study, the objectives of study are as follows:

- To identify the elements of cost of quality in construction projects as quantitative measurement for assessing principles of the QMS tools and techniques
- To identify improvement principles of QMS tools and techniques
- To identify the success factors of an intelligent assessment and improvement system as self assessment and self improvement framework system
- To develop a framework technique and it's tools, for cost assessment of implemented QMS tools for building contractors

## 1.5 Scope

In order to capture the objectives of this study, the scope includes reviewing previous efforts on cost quality measurement, checked out principles of Taguchi methods, process of Failure Mode and Effect Design (FMEA) and Benchmarking techniques as its Quality engineering methodologies. Furthermore, this study will review Shainin, Demings 14 point for Plan for TQM, Six-Sigma and finally Kaizen management philosophy. It will also include reviewed objectives of intelligent systems, for this part, this study only have been focused on BIS as it's based intelligent system.

In this research cause of different nature of construction projects like dam, road, air port, high rise building, office buildings project and further; researcher has selected office building construction to focus on. Besides, In order to make a feasible model as time ruled, scope for study is limited only in alike building projects. In term of cost and function from the same contractor, it is to insure that it has equality in all driven

managerial tools and systems for data mining of Quality Performance. Also for simplicity it is assumed that there is no different in cost of similar work in different project which also means that area is economically stable.

Another limitation of scope is having a procurement method of contract, which with believe of complexity of collaborative teamwork environment, this study has choose collaborative team work environments such as build and design procurement system as a scope of implementing model.