

INTEGRATED ENVIRONMENTAL MANAGEMENT SYSTEMS IN EGYPTIAN HOSPITALS

Submitted by

Iman Mohamed Youssri Hassan Osman

B.Sc. In Civil Engineering, Faculty of Engineering, Cairo University, 2000

Diploma in Environmental Sciences, Faculty of Graduate Studies and
Environmental Research, Ain Shams University, 2005

Master in Environmental Sciences, Faculty of Graduate Studies and
Environmental Research, Ain Shams University, 2011

A Thesis Submitted in Partial Fulfillment

Of

The Requirement for the Doctor of Philosophy Degree

In

Environmental Sciences

Department of Environmental Engineering Sciences
Faculty of Graduate Studies and Environmental Research
Ain Shams University

2022

APPROVAL SHEET

INTEGRATED ENVIRONMENTAL MANAGEMENT SYSTEMS IN EGYPTIAN HOSPITALS

Submitted by

Iman Mohamed Youssri Hassan Osman

B.Sc. In Civil Engineering, Faculty of Engineering, Cairo University, 2000

Diploma in Environmental Sciences, Faculty of Graduate Studies and

Environmental Research, Ain Shams University, 2005

Master in Environmental Sciences, Faculty of Graduate Studies and

Environmental Research, Ain Shams University, 2011

A Thesis Submitted in Partial Fulfillment

Of

The Requirement for the Doctor of Philosophy Degree

In

Environmental Sciences

Department of Environmental Engineering Sciences

This thesis was discussed and approved by:

Name

Signature

1-Prof. Dr. Ahmed Abdel Aziz Abdel Ghafar

Prof. and Head of Department of Surgery

Faculty of Medicine

Al-Azhar University

2-Prof. Dr. Tarek Ismail Mahmoud Sabry

Prof. of Sanitary Engineering

Faculty of Engineering

Ain Shams University

3-Prof. Dr. Mohammed El Hosseiny El Nadi

Emeritus Prof. of Sanitary & Environmental Engineering

Faculty of Engineering

Ain Shams University

2022

INTEGRATED ENVIRONMENTAL MANAGEMENT SYSTEMS IN EGYPTIAN HOSPITALS

Submitted by

Iman Mohamed Youssri Hassan Osman

B.Sc. In Civil Engineering, Faculty of Engineering, Cairo University, 2000

Diploma in Environmental Sciences, Faculty of Graduate Studies and
Environmental Research, Ain Shams University, 2005

Master in Environmental Sciences, Faculty of Graduate Studies and
Environmental Research, Ain Shams University, 2011

A Thesis Submitted in Partial Fulfillment
Of

The Requirement for the Doctor of Philosophy Degree
In

Environmental Sciences

Department of Environmental Engineering Sciences

Under The Supervision of:

1-Prof. Dr. Mohamed El Hosseiny El Nadi

Emeritus Prof. of Sanitary & Environmental Engineering
Faculty of Engineering
Ain Shams University

2-Prof. Dr. Asser Moustafa El-Afifi

Prof. of Surgery & Deputy director of Ain Shams University Hospitals
Ain Shams University

3-Prof. Dr. Khaled Hussein Taman (Dead)

Prof. of Childhood
Faculty of Post Graduate of Childhood
Ain Shams University

2022

ACKNOWLEDGEMENT

I sincerely appreciate Almighty God for his grace, sustenance strength, and benevolence that made me excel and succeed in all my academic pursuits.

I have no words to express my sincere thanks, appreciation, and gratitude to my advisor, Prof. Dr. Mohammed El- Hosseiny, I will be forever grateful for his guidance, and continuous support, he instilled in me the values of scientific inquiry and intellectual integrity, also the countless hours of attention he devoted throughout the course of this thesis.

I would like also to thank Prof. Dr. Khaled Hussien Taman, who passed away during the last stage of my work on this thesis, many thanks for his kind assistance, he has provided me extensive professional guidance, his valuable comments made a great influence on my work. I am very grateful for helping me to develop my medical background.

I extend my sincere profound gratitude to Prof. Dr. Asser Moustafa El-Afifi, for accepting the supervision and completion of this thesis, also for teaching me a great deal about hospital management.

My deep and sincere gratitude to my parents for their continuous and unparalleled love, support, I am forever indebted to them for giving me the opportunities and experiences that have made me who I am. My mother who have extended their unlimited love, constant prayers and kindness to me throughout my life. I am grateful to my father for always being a role model to me. Also, I wish to thank my supportive husband, and my wonderful children, for their patience and encouragement.

ABSTRACT

Healthcare facilities are energy and resource-intensive enterprise. This sector is a major consumer of resources, as they open 24 hours a day, 365 days a year, also function as offices, laboratories, commercial laundries, lodging establishments, food service providers, and in many cases they are used as energy generators and waste treatment enterprises. Each of those activities make them a design complicated building type, which requires an efficient integrated environmental management system afterwards.

Therefore, the research contributes to setting a new foundation for integrated hospital management throughout two perspectives: technical and environmental, this is for enhancing the operations for the existing hospital efficiently, given that, the budget which is allocated for operation, development and maintenance is very limited, so this program takes into account in its outputs; technically and environmentally accepted solutions; and such solutions are being implemented at the lowest possible cost and do not cause hinder or disruption of operations.

TABLE OF CONTENTS

Subject	Page No.
APPROVAL SHEET	i
ACKNOWLEDGEMENT	ii
ABSTRACT.....	iii
TABLE OF CONTENTS.....	iv
LIST OF TABLES.....	ix
LIST OF FIGURES	x
CHAPTER I	1
INTTRODUCTION.....	1
1.1 BACKGROUND	1
1.2 STUDY OBJECTIVES.....	2
1.3 SCOPE OF WORK.....	2
1.3.1 THEORTICAL PART	2
1.3.2 EXPERIMENTAL PART.....	3
1.4 THESIS ORGANIZATION.....	3
1.4.1 CHAPTER I: INTRODUCTION.....	3
1.4.2 CHAPTER II: LITERATURE REVIEW	3
1.4.3 CHAPTER III: MATERIALS AND METHODS	4
1.4.4 CHAPTER IV: RESULTS.....	4
1.4.5 CHAPTER V: MODELLING.....	4
1.4.6 CHAPTER VI: DISCUSSION	4
1.4.7 CHAPTER VII: CONCLUSION.....	4
CHAPTER II	5
LITERATURE REVIEW	5
2.1 INTRODUCTION	5
2.2 CLASSIFICATION OF HOSPITALS	6
2.2.1 IN TERMS OF FUNCTIONALITY.....	6
2.2.2 IN TERMS OF SIZE	7
2.2.3 IN TERMS OF LOCATION	7
2.2.4 IN TERMS OF OWNERSHIP.....	7
2.2.5 IN TERMS OF SPECIALIZATIONS	7
2.2.6 IN TERMS OF MANAGEMENT TECHNIQUES.....	8
2.2.7 IN TERMS OF LENGTH OF STAY	8
2.3 WORLD EXPERIENCE	8
2.4 HOSPITALS SYSTEM IN EGYPT	10
2.4.1 PUBLIC HEALTH CARE SYSTEM.....	12
2.4.2 PRIVATE HEALTH CARE SYSTEM	13
2.5 MANAGEMENT OF EGYPTIAN HEALTH CARE SYSTEM.....	14

2.5.1 POLICY, PLANNING AND MANAGEMENT OF NATIONAL HEALTH POLICY	15
2.5.1.1 Integration of Services	17
2.6 EGYPT'S HEALTH CARE SYSTEM PROVIDERS BY NHA.....	18
2.6.1 THE EGYPTIAN HEALTH SYSTEM IN BRIEF	18
2.6.1.1 Public Sector	19
2.6.1.2 Public Governmental Sector:	19
2.6.1.3 Private Sector	19
2.7 MANAGEMENT, PLANNING & DESIGNING OF HOSPITALS	20
2.7.1 SITE DESIGN AND SELECTION	20
2.7.1.1 Site Utilization	20
2.7.1.2 Size Of The Site	20
2.7.2. BUILDING DESIGN STANDARDS.....	21
2.7.2.1 Ramps	21
2.7.2.2 Corridors design.....	21
2.7.2.3 Ceiling.....	23
2.7.2.4 FINISHES	24
2.7.2.5 Doors.....	26
2.7.2.6 Windows	28
2.7.2.7 Screens and Louvers	29
2.7.2.8 Floor Joints.....	29
2.7.2.9 Plumbing Fittings.....	29
2.7.2.10 Energy Conservation and Management.....	30
2.7.3 ENVIRONMENTAL DESIGN	30
2.7.3.1 Planning	30
2.7.3.2 Noise Control.....	31
2.7.3.3 Background Noise.....	31
2.7.3.4 Noise by Hydraulic causes.....	31
2.7.3.5 Acoustic Isolation	32
2.7.3.6 Room Acoustics	32
2.7.3.7 Light Control.....	33
2.7.3.8 Mechanical Acoustics	33
2.7.3.9 Vibration	33
2.7.4 WATER, SANITATION AND WASTE MANAGEMENT.....	34
2.7.4.1 Disposal System Selection.....	34
2.7.4.2 Health Care Waste Management	35
2.7.4.3 Handling.....	35
2.7.4.4 Treatment and Disposal	35
2.7.4.5 Waste Management Organization.....	36

2.8 STRATEGIC OF PLANNING	36
2.8.1 SWOT FACTORS	37
2.9 WORLD STUDIES ON HEALTHCARE FACILITY DESIGN AND MANAGEMENT	38
2.9.1 IMPLEMENTING BUILDING VIRTUAL DESIGN AND CONSTRUCTION (VDC) TECHNOLOGIES	40
2.9.2 PLANNING, BUILDING, MERGING, AND CLOSING HOSPITALS	42
2.9.3 APPLYING LEAN PRINCIPLES TO THE DESIGN OF HEALTHCARE FACILITIES.....	43
2.9.4 INNOVATIVE DESIGN SOLUTIONS FOR HOSPITAL UNITS.....	44
2.9.5 DESIGN FACTORS RELATED TO PHYSICAL ENVIRONMENTS IN HOSPITALS	45
2.9.6 A COMPARATIVE ASSESSMENT OF A HOSPITAL.....	46
2.9.7 CRITERIA IMPLEMENTATION IN HOSPITAL PLANNING AND DESIGN	47
2.10 HEALTHCARE GREEN CONCEPT AND SUSTAINABILITY..	50
2.10.1 HEALTHCARE BUILDING SUSTAINABILITY ASSESSMENT METHOD.....	51
2.10.2 GOVERNANCE STRUCTURES FOR HEALTH- CARE WASTE MANAGEMENT	52
2.11 HEALTHCARE WASTE MANAGEMENT	53
2.11.1 ASSESSMENT OF HEALTHCARE WASTE MANAGEMENT IN A HUMANITY CRISIS	53
CHAPTER III	55
MATERIALS AND METHODS.....	55
3.1 FRAMEWORK OF METHODOLOGY	55
3.2 QUESTIONNAIRE DESIGN.....	56
3.3 DATA COLLECTION	58
3.4 LOCATION STUDY	59
3.5 PROBLEM STATEMENT	61
3.6 INSTRUMENTATION AND DATA ANALYSIS.....	61
3.7 SAMPLE SIZE	62
3.8 QUESTIONNAIRE's COMPONENT & ANALYSIS.....	62
3.8.1 LOCATION, ACCESSIBILITY, DESIGN, STRUCTURE & ARCHITECTURE	62
3.8.1.1 Site Location and Access.....	64
3.8.1.2 Designs Criteria	65
3.8.1.3 Finishes	65

3.8.2 UTILITIES & SERVICES.....	66
3.8.3 SAFETY AND SECURITY	68
3.8.3.1 Fire Safety	69
3.8.3.2 Hospital Security Arrangements	70
3.8.3.3 Patient safety in hospital	70
3.8.4 WASTE MANAGEMENT PROCEDURES	70
3.8.4.1 Handling.....	70
3.8.4.2 Storage	71
3.8.4.3 Treatment	71
3.8.4.4 Transport	71
3.8.4.5 Disposal.....	72
3.8.5 COMMUNICATIONS, TRANSPORTATION & INFORMATION SYSTEMS.....	72
3.8.6 HUMAN RESOURCES	72
3.8.7 STAFF & PATIENT SATISFACTION	73
CHAPTER IV	74
RESULTS	74
4.1 GENERAL.....	74
4.2 QUESTIONNAIRE ReSULTS.....	78
4.3 EVALUATION OF AN OPERATED HEALTHCARE FACILITY	95
CHAPTER V	98
MODELLING.....	98
5.1 INTRODUCTION	98
5.2 MODEL GENERATION.....	102
5.3 CRITERIA FOR SELECTING THE HEALTH CARE FACILITY	104
5.4 PURPOSE OF THE MODEL.....	105
5.5INTEGRATED ENVIRONMENTAL MANAGEMENT MODEL	106
CHAPTER VI	137
DISCUSSION	137
6.1 GENERAL.....	137
6.2 MODEL APPLICATION	138
6.2.1 INTEGRATED MODEL APPLICATION.....	140
6.2.2 EVALUATION OF STAGE I - BUILDING PROPERTIES	153
6.2.2.1 Hospital Structure	153
6.2.2.2 Hospital Architecture –Interiors	154
6.2.2.3 Hospital Architecture –Exteriors	161
6.2.2.4 Hospital Landscape.....	162
6.2.3 EVALUATION OF STAGE II –INFRASTRUCTURE.....	163

6.2.3.1 Roof.....	163
6.2.3.2 For the 8 th Floor	164
6.2.3.3 For All Bathrooms In Typical Floors.....	164
6.2.3.4 For Catheters Building's Roof.....	164
6.2.3.5 Sterilization Area	165
6.2.3.6 Basement Floor	165
6.2.3.7 Service Building.....	165
6.2.3.8 Water.....	166
6.2.3.9 Sewage	167
6.2.3.10 Solid Wastes.....	167
6.2.3.11 Electricity	169
6.2.3.12 HVAC	170
6.2.3.13 Medical Gases	172
6.2.3.14 Firefighting System.....	173
6.3 HOSPITAL IMPROVEMENT	174
CHAPTER VII	176
CONCLUSION.....	176
7.1 OVERVIEW	176
7.2 CONCLUSION.....	177
7.3 RECOMMENDATIONS	178
7.4 FUTURE WORKS.....	178
SUMMARY	180
REFERENCES	184
ARABIC ABSTRACT & SUMMARY.....	
ARABIC APPROVAL SHEET	
ARABIC COVER.....	

LIST OF TABLES

No.	Title	Page
CHAPTER II LITERATURE REVIEW		
2/1	Distribution of Health Facilities in Egypt, 2005	15
2/2	Human Resources Availability and Creation / For MOHP Staff Only, Per 10,000	16
2/3	Bed / Population by Governorate and Type of Provider, 2005	16
2/4	Comparison for Master plan, SFP and Tactical Plan	37
CHAPTER IV RESULTS		
4/1	Number of Egyptian Hospitals Yr. (2005-2016)	75
4/2	Egyptian Hospitals Numbers of Beds Yr. (2005-2016)	75
4/3	Egyptian Hospitals Numbers / Governorate Yr. (2016)	76
4/4	Egyptian Expenditure on Health Sector Yr. (2017/2018)	76
CHAPTER VI DISCUSSION		
6/1	Running the Integrated Management Model on the Case Study Hospital	142
6/2	Application of the Integrated Management Model on the Case Study Hospital	176

LIST OF FIGURES

No.	Title	Page
CHAPTER II LITERATURE REVIEW		
2/1	Qasr El Ainey Hospital	6
2/2	New healthcare system in United Kingdom	9
2/3	Healthcare System in Australia	10
2/4	Sources of Healthcare Funding in Egypt, 2002	18
2/5	Standards for Hospital Operation Theatres	25
2/6	Standards for Clear Opening in Patient Room Doors	26
2/7	SWOT	38
CHAPTER III MATERIALS AND METHODS		
3/1	Questionnaire Main Phases	57
3/2	Hospital Location	59
3/3	Ground Floor Plan	60
3/4	First Floor Plan	60
CHAPTER IV RESULTS		
4/1	Questionnaire Results	94
CHAPTER V MODELLING		
5/1	Integrated Environmental Model Strategy	107
5/2	Hospital Inventory	108
5/3	Inventory - Structure	109
5/4	Inventory - Architecture Exteriors	110
5/5	Inventory - Architecture– Interiors	111
5/6	Inventory - Landscape (Planting)	112
5/7	Inventory - Landscape (Hardscape)	113
5/8	Inventory - Electrical	114
5/9	Inventory - HVAC	115
5/10	Inventory - Plumbing/1	116
5/11	Inventory - Plumbing/2	117
5/12	Inventory - Plumbing/3	118
5/13	Inventory – Sewage/1	119
5/14	Inventory – Sewage/2	120

No.	Title	Page
CHAPTER V MODELLING		
5/15	Inventory – Sewage/3	121
5/16	Inventory - Solid waste	122
5/17	Inventory - Medical Gas	123
5/18	Inventory - Fire Fighting/1	124
5/19	Inventory -Fire Fighting/2	125
5/20	Evaluation -Structure	126
5/21	Evaluation –Architecture/Interior	127
5/22	Evaluation –Architecture/Exterior	128
5/23	Evaluation - Landscape	129
5/24	Evaluation - Electrical	130
5/25	Evaluation -HVAC	131
5/26	Evaluation - Plumbing	132
5/27	Evaluation - Sewage	133
5/28	Evaluation – Solid Waste	134
5/29	Evaluation –Medical Gas	135
5/30	Evaluation –Fire Fighting	136
CHAPTER VI DISCUSSION		
6/1a	Building Properties – Stage I	140
6/1b	Infrastructure – Stage II	140
6/2	Integrated model application on Building’s “Structure”	142
6/3	Integrated model application on Building’s “Architecture-Interiors”	143
6/4	Integrated model application on Building’s “Architecture-Exteriors”	144
6/5	Integrated model application on Building’s “Landscape”	145
6/6	Integrated model application on Building’s “Water Network”	146
6/7	Integrated model application on Building’s “Electricity”	147
6/8	Integrated model application on Building’s “Sewage”	148

No.	Title	Page
	CHAPTER VI DISCUSSION	
6/9	Integrated model application on Building's "HVAC"	149
6/10	Integrated model application on Building's "Fire Fighting"	150
6/11	Integrated model application on Building's "Medical Gases"	151
6/12	Integrated model application on Building's "Solid Waste"	152
6/13	Types of Structural Cracks	154
6/14	Existed Ceiling System	155
6/15	Damped Ceiling Spots	155
6/16	Existed Ceiling tiles	156
6/17	Hospital Atrium	156
6/18	Stone Flooring	157
6/19	Ceramic Flooring	157
6/20	Vinyl Flooring	158
6/21	Stone Flooring in patient rooms	158
6/22	Stone Flooring in public areas	158
6/23	Kitchen flooring	159
6/24	Patients' Rooms	160
6/25	Internal Doors	160
6/26	Architecture-Exterior (1)	161
6/27	Architecture-Exterior (2)	162
6/28	Architecture-Exterior (3)	162
6/29	Satellite Map for the Hospital's location	163