AN INTEGRATION OF RANK ORDER CENTROID, MODIFIED ANALYTICAL HIERARCHY PROCESS AND 0-1 INTEGER PROGRAMMING IN SOLVING A FACILITY LOCATION PROBLEM

MOHAMMED AHMED SALEM BALHUWAISL

DOCTOR OF PHILOSOPHY

UNIVERSITI UTARA MALAYSIA

2013

Permission to Use

In presenting this thesis in fulfilment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the Universiti Library may make it freely available for inspection. I further agree that permission for the copying of this thesis in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor(s) or, in their absence, by the Dean of Awang Had Salleh Graduate School of Arts and Sciences. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to:

Dean of Awang Had Salleh Graduate School of Arts and Sciences

UUM College of Arts and Sciences

Universiti Utara Malaysia

06010 UUM Sintok

Abstrak

Daerah Hadhramout merupakan pengeluar utama kurma di Republik Yaman. Walaupun pengeluaran kurma tinggi dari segi kuantiti mahupun kualiti, kerugian perniagaan sangat tinggi. Keadaan ini diburukkan lagi dengan aktiviti pasaran gelap yang berleluasa. Baru-baru ini, kerajaan Yaman telah menyatakan persetujuan tentang pentingnya pembinaan satu kilang pembungkusan kurma sebagai satu penyelesaian kepada masalah-masalah tersebut. Oleh itu, kajian ini bertujuan untuk mengenal pasti lokasi terbaik di antara tujuh daerah yang mengeluarkan kurma di Hadhramout. Pilihan dibuat berdasarkan sebelas kriteria yang dikenal pasti oleh beberapa wakil pekebun dan majlis tempatan. Kriteria tersebut ialah pertumbuhan pasaran, jarak dengan pasaran, jarak dengan bahan mentah, buruh, iklim buruh, pembekal, komuniti, kos pengangkutan, faktor alam sekitar, kos pengeluaran, dan kos pembinaan kilang. Darjah kepentingan dan pemberat sepadan bagi setiap kriterion dikira menggunakan dua pendekatan, iaitu Proses Hierarki Analitik (AHP) dan Sentroid Tertib Pangkat (ROC). Dalam memanfaatkan AHP, sedikit pengubahsuaian telah dilaksanakan pada langkah perbandingan berpasangan yang menghapuskan masalah ketidaktekalan yang dihadapi dalam peraturan perbandingan berpasangan pada AHP piawai. Begitu juga yang dilakukan dalam menggunakan ROC yang mana teknik penormalan telah dicadangkan untuk menyelesaikan masalah pemberian pemberat pada kriteria yang mempunyai aras keutamaan yang sama, yang tidak dijelaskan atau dinyatakan dalam ROC piawai. Kedua-dua kaedah yang dimanfaatkan menyatakan pembekal merupakan kriterion paling penting, manakala komuniti dianggap kriterion paling tidak penting dalam memutuskan lokasi akhir kilang kurma. Menggabungkan pemberat kriteria dengan beberapa kekangan keras dan lembut yang perlu dipenuhi oleh lokasi, lokasi akhir ditentukan dengan menggunakan tiga model matematik, iaitu, ROC digabungkan dengan model pengaturcaraan integer 0-1, AHP digabungkan dengan model pengaturcaraan integer 0-1, dan purata ROC dan AHP digabungkan dengan model pengaturcaraan integer 0-1. Ketiga-tiga model menghasilkan keputusan yang sama; Doean ialah lokasi terbaik. Keputusan kajian ini jika dilaksanakan, diharap dapat membantu kerajaan Yaman dalam usaha mereka untuk memajukan pengurusan kurma di Hadhramout.

Kata Kunci: Proses Hierarki Analitik, Sentroid Tertib Pangkat, model pengaturcaraan integer 0-1, lokasi kemudahan

Abstract

Hadhramout province is the major producer of dates in The Republic of Yemen. Despite producing substantial quantity and quality of dates, the business losses are still high. The situation worsens with the widespread of the black market activities. Recently, the Yemeni government has issued an agreement stating the importance of building a date palm packaging factory as a resolution to the problems. Hence, this study aims to identify the best location for a date palm packaging factory among the seven districts which produce most of the date palm supplies in Hadhramout. The selection was based on eleven criteria identified by several representatives from the farmers and the local councils. These criteria were market growth, proximity to the markets, proximity to the raw materials, labor, labor climate, suppliers, community, transportation cost, environmental factors, production cost, and factory set up cost. The level of importance and the respective weight of each criterion were calculated using two different approaches, namely, Analytic Hierarchy Process (AHP) and Rank Order Centroid (ROC). In applying AHP, a slight modification was made in the pairwise comparison exercises that eliminated the inconsistency problem faced by the standard AHP pairwise comparison procedure. Likewise, in applying ROC, a normalization technique was proposed to tackle the problem of assigning weights to criteria having the same priority level, which was neither clarified nor available in the standard ROC. Both proposed techniques revealed that suppliers were the most important criterion, while community was regarded to be the least important criterion in deciding the final location for the date palm factory. Combining the criteria weights together with several hard and soft constraints that were required to be satisfied by the location, the final location was determined using three different mathematical models, namely, the ROC combined with 0-1 integer programming model, the AHP combined with 0-1 integer programming model, and the mean of ROC and AHP combined with 0-1 integer programming model. The three models produced the same result; Doean was the best location. The result of this study, if implemented, would hopefully help the Yemeni government in their effort to improve the production as well as the management of the date palm tree in Hadhramout.

Keywords: Analytic Hierarchy Process, Rank Order Centroid, 0-1 integer programming model, Facility location.

Acknowledgement

First and foremost, I would like to express my sincere and heartfelt gratitude towards Allah the Almighty for endowing me with the power, courage and determination in completing my thesis. I wish to convey my most sincere appreciation to my supervisor; Assoc. Prof. Dr. Engku Muhammad Nazri Bin Engku Abu Bakar and co-supervisor; Dr. Maznah Binti Mat Kasim, without their guidance it would not have been possible for me to complete this thesis in the present form. They have been a helpful guide, a severe critic and great friends. I will always be indebted to them for their patience, understanding and advice throughout the preparation of this thesis.

I would like to express my most sincere and warmest gratitude to my family and my relatives for their prayers, assistance and encouragement throughout my study. I think words can never adequately express how grateful I am to my parents. I can only say a word of thanks to my father and mother for their prayers, patience and untiring support in every way during my long absence from the family. I humbly acknowledge the patience, perseverance and encouragement of my wife and sons during my study. My gratitude is also extended to both my grandmothers, brothers, sisters and uncles for their motivation and confidence on me.

I would also like to thank Hadhramout University for Science and Technology (HUST) for granting me permission to conduct this study and for sponsoring my scholarship. I would also like to extend my thanks to the staff members of the Faculty of Quantitative science in the College of Arts and Sciences in Universiti Utara Malaysia for being a rich resource in giving me theoretical and practical doses in designing and implementing this

research. I owe a great deal of gratitude to the College of Arts and Sciences in Universiti Utara Malaysia as well as the University's Library.

I am extremely grateful to Mr. Khaled Aljaadi, who helped me in checking the language writing. My profound thanks and appreciation to Prof. Elmostafa Kalmoun and Assoc. Prof. Dr. Razamin Ramli for their valuable advice, suggestions and helpful during my study. My sincere and heartfelt appreciation to Mr Rais Attamimi for his constant encouragement, companionship and moral sustenance without which this thesis would not have materialized. My heartfelt appreciation also goes to all the other friends and colleagues who helped me, in any way or form, until the research reached its conclusion.

Table of Contents

Permission to Use ii
Abstrak iii
Abstract iv
Acknowledgement v
Table of Contents vii
List of Tables xi
List of Figures xiii
List of Appendices xv

CHAPTER ONE INTRODUCTION 1
1.1 Facility Location Problem 1
1.1.1 Facility Location Problem in Hadhramout 3
1.1.2 Criteria in Facility Location Problem 8
1.1.3 Objective Function(s) in Facility Location Problem 11
1.1.4 Facility Location Problem in Terms of Techniques 13
1.1.5 Analytic Hierarchy Process Technique and its Consistency 16
1.2 Problem Statement 18
1.3 Objectives of Study 20
1.4 Scope of the Study 20
1.5 Contribution of the Study 21
1.5.1 Theoretical Aspect 21
1.5.2 Practical Aspect 22
1.5.2.1 Benefits of Study 22
1.5.2.2 Facility Location Problem in Yemen 23
1.5.2.3 Facility Location Problem Criteria 23
1.5.2.4 Researchers and Academic Community 23
1.6 Thesis Organization 24

CHAPTER TWO IDENTIFICATION OF CRITERIA AND THE EVALUATION TECHNIQUES IN FACILITY LOCATION PROBLEMS 26

2.1 Classification of Facility Location Models, Objectives and Criteria used ……. 26
2.1.1 Facility location models ……... 26
2.1.2 Objective Functions Used in Facility Location Problems ……... 27
2.1.3 Criteria used in facility location problems ……... 28
2.1.3.1 Cost ……. 28
2.1.3.2 Labor Availability ……... 30
2.1.3.3 Proximity to Market …… 30
2.1.3.4 Proximity to Raw Materials …… 30
2.1.3.5 Proximity of Resources to Suppliers …… 31
2.1.3.6 Proximity to Customers …….. 31
2.1.3.7 Land Availability …… 31
2.1.3.8 Capital ……. 32
2.1.3.9 Community Infrastructure and Amenity ……. 32
2.1.3.10 Government Regulation …… 32
2.1.3.11 Other Criteria …… 33
2.2 Multiple Criteria Decision Making …… 33
2.2.1 Identification of the Criteria ……. 35
2.2.2 Evaluation of the Criteria ……. 36
2.2.2.1 Ranking Methods …… 37
2.2.2.2 Pairwise Comparison Method ……. 39
2.2.2.3 Other Criteria Evaluation Techniques …… 52
2.3 Discussion and Summary ……... 54

CHAPTER THREE SINGLE AND INTEGRATED SELECTION MODELS…… 56

3.1 Single Selection Models 56
3.1.1 Technique for Order Preference by Similarity to Ideal Solution ……. 56
3.1.2 The Analytical Network Process ……. 58
3.1.3 Scoring Model Technique …… 60
3.1.4 ELECTRE III Technique ……. 61
3.1.5 AHP Technique ……... 62
3.1.6 Other Single Selection Models of Optimization Type 64
3.1.6.1 Linear Programming 64
3.1.6.2 Integer and Mixed Integer Linear Programming 66

3.1.6.3 Goal Programming 67
3.2 Integrated Selection Models 71
3.3 Summary 72

CHAPTER FOUR RESEARCH METHODOLOGY 74

4.1 Research Design 74
4.2 Preliminary Study: Criteria Determination 75
4.2.1 Data and Source of Data 75
4.2.1.1 The Primary Data 75
4.2.1.2 The Secondary Data 75
4.2.2 Data Collection Procedures 76
4.2.3 Criteria Identification 77
4.3 Main Study: Ranking the Criteria and Location Factory Selection 78
4.3.1 Source of Data and Data Collection 78
4.3.2 The Respondents 79
4.3.3 Data Collection Instruments 79
4.3.4 Data Analysis Technique 80
4.3.4.1 Rank Order Centroid Technique 80
4.3.4.1(a) Possibility 1: Unique Ranking of the Criteria 81
4.3.4.1(b) Possibility 2: Equal Ranking of the Criteria 82
4.3.4.2 Analytic Hierarchy Process Technique 83
4.3.4.2(a). Prove of Pairwise Consistency Using the New Approach 89
4.3.4.3 Combination of AHP and ROC 96
4.3.4.4 Utilizing the Weights for Criteria Obtained in ROC with 0-1 IP 97
4.3.4.5 Utilizing the Weights for Criteria Obtained in AHP with 0-1 IP 97
4.3.4.6 Utilizing the Weights for Criteria Obtained in ROC + AHP with 0-1 IP 98

CHAPTER FIVE RESULTS AND DISCUSSION 100

5.1 The Profile of the Respondents 100
5.2 Analysis of the Identification of the Criteria 102
5.2.1 Justification of the criteria 105
5.3 Analysis of Main Study (Criteria Weights) 105
5.3.1 Ranking of Criteria Using Rank Order Centriod Technique..... 105
5.3.1.1 Possibility One: Unique Ranking of the Criteria 106
5.3.1.2 Possibility Two: Equal Ranking of the Criteria 107

5.3.2 Ranking of the Criteria Using the AHP Technique 108
5.3.3 Analysis of Weighting Mean of ROC and AHP …… 116
5.4 Factory Location Selection ……... 118
5.4.1 Combined ROC- 0-1 IP Model ……... 121
5.4.2 Combined AHP- 0-1 IP Model ……... 125
5.4.3 Combined the Mean of ROC and AHP with 0-1 IP …….. 127
5.5 Conclusion …… 131

CHAPTER SIX CONCLUSION AND RECOMMENDATIONS ……. .133

6.1 Summary of the Study …….. 133
6.2 Limitation of the Study ……. 135
6.3 Assumptions of the Study ……. 136
6.4 Contribution of the Study ……. 136
6.4.1 Theoretical Part 137
6.4.2 Practical Part 137
6.5 Future Research …… 137

REFERENCES …….....139

List of Tables

Table 1.1	The area production area and the production in Yemen……	3
Table 1.2	Total area and production in each district in Hadhramout…….	6
Table 1.3	Categories of criteria for facility location problem ……...	10
Table 2.1	Preference scale for pairwise comparisons……...	42
Table 2.2	importance scale of information evolution using direct rating...	53
Table 4.1	Calculation the weight for the one respondent……...	81
Table 4.2	Calculation the weight and final weight for the one respondent	82
Table 4.3	Interpretation of the values used in pairwise comparison matrix ……	87
Table 4.4	The pairwise comparison matrix……	88
Table 4.5(i)	Rating table for *m* = 3…….	90
Table 4.5(ii)	Converted pairwise comparison table for m = 3……	91
Table 4.6(i)	Rating table for *m* = 4…….	91
Table 4.6(ii)	Converted pairwise comparison table for m = 4……	91
Table 4.7(i)	Rating table for *m* = 5……..	92
Table 4.7(ii)	Converted pairwise comparison table for m = 5……	92
Table 4.8(i)	Rating table for *m* = 6……	92
Table 4.8(ii)	Converted pairwise comparison table for m = 6……	92
Table 4.9(i)	Rating table for *m* = 7…….	93
Table 4.9(ii)	Converted pairwise comparison table for *m* = 7…….	93
Table 4.10(i)	rating table for *m* = 8……..	93
Table 4.10(ii)	Converted pairwise comparison table for *m* = 8…….	94
Table 4.11(i)	Rating table for *m* = 9…….	94
Table 4.11(ii)	Converted pairwise comparison table for *m* = 9…….	95
Table 4.12	Summary of pairwise comparison experiments…….	95
Table 5.1	Number of the farmers and decision makers in each district….	101
Table 5.2	Descriptive analysis of educational level of the decision…….. makers and farmers	102
Table 5.3	Main criteria and sub-criteria…….	103
Table 5.4	The weight by the first respondent for all the criteria……	106
Table 5.5	Final weights and ranks for the criteria using ROC model for.. the whole group	108
Table 5.6	The importance of selection criteria for factory location by….. first respondent	110
Table 5.7	The pairwise comparison matrix and the summation of each… column for the first respondent	111
Table 5.8	Final weights and rank for the criteria using AHP model for… the first respondent	112
Table 5.9	Descriptive analysis of the criteria weights and the values of consistency ratio, CR for all 21 evauations	113
Table 5.10	Final weights and rank for the criteria using AHP model…….	114
Table 5.11	Comparison of the rank of the criteria in ROC and AHP models……	115

Table 5.12	Final weights and rank for the criteria using the mean of ROC and AHP model……..	116
Table 5.13	Comparison of the rank of the criteria in the three models……	117
Table 5.14	Summary of the results of three models in USD ……	130

List of Figures

Figure 1.1 The location of Yemen and the provinces that produce the date palm trees 4
Figure 1.2 Districts in Hadhramout province that produce the date palm trees 5
Figure 4.1 Hierarchy for place of factory selection problem 85
Figure 5.1 The identified selection criteria of prospective locations……104

List of Abbreviations

AHP	Analytical Hierarchy Process
ANP	Analytical Network Process
CI	Inconsistency Index
CR	Consistency Ratio
DEA	Data Envelopment Analysis
FL	Facility location
GCI	Geometric Consistency Index
GP	Goal Programming
ILP	Integer Linear Programming
LP	Linear Programming
MILP	Mixed Integer Linear Programming
MEW	Multiplicative Exponential Weighting
MCDM	Multi Criteria Decision Making
OR	operations research
QFD	Quality Function Deployment
ROC	Rank Order Centroid
RS	Rank Sum
RR	Reciprocal the Ranks
SWOT	Strengths, Weaknesses, Opportunities, Threats
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
0-1 IP	0-1 Integer Programming

List of Appendices

Appendix A Questionnaire for Rank Order Centroid Technique…….. 158

Appendix B Questionnaire for Analytical Hierarchy Process Technique……...159

Appendix C Questionnaire for 0-1 Integer Programming……...161

Appendix D Final Weights of all the Respondents for the Criteria Using ROC…162

Appendix E First Respondent Calculations by Using AHP...……..... 165

Appendix F Final Weights of all the Respondents for the Criteria and the Consistency Using AHP…….170

Appendix G Estimated Values for the Criteria in each Location to Apply 0-1 Integer Programming ……..…….172

CHAPTER ONE

INTRODUCTION

This chapter begins with a brief overview of the background of the facility location problem. This is followed by the statement of the problem, objectives and research questions, scope of the study, and contribution of the study.The chapter concludes with a brief statement on the organization of this entire thesis.

1.1 Facility Location Problem

Facility location, also known as location analysis, is a branch of operations research and computational geometry. It concerns itself with mathematical modeling and solution of problems about optimal placement of facilities in order to select the best solution. In particular, facility location is a cycle of processes. It starts with the planning stage and ends with a selection that implies options presuming the existence of different alternatives for analysis by the decision makers. Meanwhile, every alternative has its own characteristics and facilities.

Determining a final site selection in a facility location problem is an important task as the site selection is directly linked to many warehouse systems, inventory control and handling activities, as well as customers and suppliers. A good location offers a strategic advantage against competitors. As an example, locating more outlets ensures accessibility and the offering of better services to potential customers over short distances (Jayaraman, 1998, and Ghosh 2009).

Locating facilities to serve customers has been a serious problem in operations research, computer science, and business applications (Kumral, 2004). Variations of

The contents of the thesis is for internal user only

REFERENCES

Abbas, T. E., Homayonfar, M., Aghaziarati, M., and Arbabiun, P. (2011). A subjective weighting method based on group decision making for ranking and measuring criteria values. *Australian Journal of Basic and Applied* Sciences, *5*(12), 2034-2040.

Aguaron, J., and Moreno-Jimenez, J. M., (2003). The geometric consistency index: Approximated thresholds. *Journal of Operational Research*, 147(1), 137-145.

Akgunduz, A., Zetu, D., Banerjee, P., and Liang, D. (2002). Evaluation of sub-component alternatives in product design processes. *Robotics and Computer Integrated Manufacturing 18*(1), 69-81.

Alakil, A. M. (2003). Objective evaluation of non-profit organizations (NPO's): An analytical hierarchy process approach. Unpublished PhD dissertation, Florida Institute of Technology, Florida.

Albareda-Sambola, M.,Diaz, J. A., and Fernandez, E.(2005). A compact model and tight bounds for a combined location routing problem. *Computers and Operations Research, 32*(3), 407-428.

Al-Katheri, M. A. (2000). Date palm trees production in Yemen and the present and future role of Hadhramout University for its development. Paper presented in the conference of using modern technique in development of productivity date palms in Arabic country, 28-30 March 2000, Alaeen, U.A.E.

Al-Kloub, B., Al-Shemmeri, T., and Pearman, A. (1997). The role of weights in multi-criteria decision aid, and the ranking of water projects in Jordan. *European Journal of Operational Research, 99*(2), 278-288.

Ariffi, H., Salit, M. S., Ismail, N., and Nukman, Y. (2008). Use of analytical hierarchy process (AHP) for selecting the best design concept. *Jurnal Teknologi*, 49(A), 1-18.

Aupperle, L., and Keil, J. M. (1989). Polynomial algorithms for restricted Euclidean p-centre problems. *Discrete Applied Mathematics, 23*(1), 25-31.

Badri, M. A. (1999). Combining the analytic hierarchy process and goal programming for global facility location-allocation problem. *International Journal of Production Economics 62*(3), 237-248.

Badri, M. A. (2001). A combined AHP-GP model for quality control systems. *International Journal of Production Economics 72* (1), 27-40.

Bameftah, M., Binhadjeh, A., Alhabeshi, K., Alsagaf, S., Basweed, G., Albar, A., Obad, S., and Albetey, S. (2005). Preliminary results of the survey for proximate varieties of dates in the Hadramout and Tihama plain. Seyuon: Sana'a. M.A.I. Yemen. p.1-4.

Bari, F., and Leung, V. (2007). Multi-attribute network selection by iterative TOPSIS for heterogeneous wireless access. Paper presented in 4th IEEE Consumer Communications and Networking Conference, 808-812.

Barron, F. H., and Barrett, B. E. (1996). Decision quality using ranked attribute weights. *Management Science, 42*(11), 1515-1525.

Bartik, T. J. (1994). Jobs productivity and local economic development: What implications does economic research have for the role of government? *National Tax Journal, 47*(4), 847-861.

Batta, R., Ghose, A., and Palekar, U. S. (1989). Locating facilities on the Manhattan metrics with arbitrary shaped barriers and convex forbidden regions. *Transportation Science, 23*(1), 26-36.

Bayazit, O. (2006). Use of analytical network process in vendor selection decisions. *Journal of Benchmarking, 13*(5), 566-579.

Belton, V. (1986). A comparison of the analytic hierarchy process and a simple multi-attribute value function. *European Journal of Operational Research, 26*(1), 7-21.

Belton, V., and Gear, A. (1983). On a shortcoming of Saaty's method of analytic hierarchies. *Omega 11*(3), 227-230.

Belton, V., and Gear, T. (1997). On the meaning of relative importance. *Journal of Multi-Criteria Decision Analysis, 6*(6), 335-338.

Bender, A., Din, A., Hoesli, M., and Brocher, S. (2000). Environmental preference of homeowners: Further evidence using the AHP method. *Journal of Property Investment and Finance, 18*(4), 445-455.

Benjamin, A. M. (2002). Housing criteria/location selection using analytical hierarchy process: A University Utara Malaysia study. Unpublished master thesis, University Utara Malaysia, Malaysia.

Berman, O., and Huang, R. (2007). The minisum multipurpose trip location problem on networks. *Transportation Science, 41*(4), 500-515.

Berman, O., and Parkan, C. (1981). A facility location problem with distance-dependent demand. *Decision Sciences, 12*(4), 623-632.

Berman, O., Drezner, Z., and Wesolowsky, G. O. (2005). The facility and transfer points location problem. *International federation of operational research societies, 12*(4), 387-402.

Berrada, I., Ferland, J. A., and Michelon P. (1996). A multi objective approach to nurse scheduling with both hard and soft constraints. *Socio Economic Planning Sciences, 30*(3), 183-93.

Bertolini, M., and Bevilacqua, M. (2006). A combined goal programming-AHP approach to maintenance selection problem. *Reliability Engineering and System Safety, 91*(7), 839-848.

Bhattacharya, A., Sarkar, B., and Mukherjee, S.K. (2005). Integrating AHP with QFD for robot selection under requirement perspective. *International Journal of Production Research, 43*(17), 3671-3685.

Bhutta, K. S., and Huq, F. (2002). Supplier selection problem: A comparison of the total cost of ownership and Analytic Hierarchy Process Approaches. *Supply Chain Management: An International Journal, 7*(3), 126-135.

Braglia, M., Gabbrielli, R., and Miconi, D. (2001). Material handling device selection in cellular manufacturing. *Journal of Multi-Criteria Decision Analysis, 10*(6), 303-315.

Brennan, J., and Edward, W. H. (1999). Where are the jobs? Cities, suburbs, and the competition for employment. The Brooking Institution. Retrieved from http://www.brookings.edu/research/reports/1999/11/jobs-hill.

Burdurlu, E., and Ejder, E. (2003). Location choice for furniture industry firms by using analytic hierarchy process G.U. *Journal of Science, 16*(20), 369-373.

Buss, T. F. (1999). The case against targeted industry strategies. *Economic Development Quarterly, 13*(4), 339-356.

Caballero, R., Gonzalez, M., Guerrero, F. M., Molina, J., and Paralera, C. (2005). Solving a multiobjective location routing problem with a metaheuristic based on tabu search. Application to a real case in Andalusia. *European Journal Operation research, 177*(3) 1751-1763.

Cebi, F., and Bayraktar, D. (2003). An integrated approach for supplier selection. *Logistics Information Management, 16*(6), 395-400.

Chan, F. T. S., and Chung, S. H. (2004a). Multi-criteria genetic optimization for

distribution network problems. *International Journal of Advanced Manufacturing Technology, 24*(7–8), 517-532.

Chan, F. T. S., and Chung, S. H. (2004b). A multi-criterion genetic algorithm for order distribution in demand driven supply chain. *International Journal of Computer Integrated Manufacturing, 17*(4), 339-351.

Chan, F. T. S., and Chung, S. H. (2005). Multicriterion genetic optimization for due date assigned distribution network problems. *Decision Support Systems, 39*(4), 661-675.

Chan, F. T. S., Chung, S. H., and Choy, K. L. (2006). Optimization of order fulfilment in distribution network problems. *Journal of Intelligent Manufacturing 17*(3), 307-319.

Chan, F. T. S., Chung, S. H., and Wadhwa, S. (2004). A heuristic methodology for order distribution in a demand driven collaborative supply chain. *International Journal of Production Research, 42*(1), 1-19.

Chan, F. T. S., Chung, S. H., and Wadhwa, S. (2005). A hybrid genetic algorithm for production and distribution. *Omega, 33*(4), 345-355.

Chan, Y., Carter, W. B., and Burnes, M. D. (2001). A multiple-depot, multiple-vehicle, location-routing problem with stochastically processed demands. *Computer and operation research, 28*(8), 803-826.

Chan, Y., Mahan, J. M., and Chrissis, J. W. (2008). Hierarchical maximal-coverage location–allocation: Case of generalized search-and-rescue. *Computers and Operations Research, 35*(6), 1886-1904.

Chang, P. T., and Lo, Y. T. (2001). Modelling of job-shop scheduling with multiple quantitative and qualitative objectives and a GA/TS mixture approach. *International Journal of Computer Integrated Manufacturing, 14*(4), 367-384.

Charles S., John B., and Paul C. (1984). Goal programming and allocating children to secondary schools in reading. *Journal Operational Research Society, 35*(8), 719-730.

Charnes, A., and Cooper, W. W. (1977). Goal programming and multiple objective optimizations: Part 1. *European Journal of Operational Research, 1*(1), 39-54.

Chen, C. T. (2000). Extensions of the TOPSIS for group decision-making under fuzzy environment. *Fuzzy Sets and Systems, 114*(1), 1-9.

Chen, R., and Handler, G. Y. (1993). The conditional P-center problem in the plane. *Naval Research Logistics, 40*(1), 117-127.

Cho, C. J. (1998). An equity-efficiency trade-off model for the optimum location of medical care facilities. *Socio-Economic Planning Sciences, 32*(2), 99-112.

Chu, S. C. K., and Chu, L. (2000). A modelling framework for hospital location and service allocation. *International Transactions in Operational Research, 7*(6), 539-568.

Chuang, P. T. (2001). Combining the analytic hierarchy process and quality function deployment for a location decision from a requirement perspective. *International Journal of Advanced Manufacturing Technology, 18*(11), 842–849.

Chung, C. H. (1986). Recent applications of the maximal covering location planning (M.C.L.P.) model. *Journal of the Operational Research Society, 37*(8), 735-746.

Crary, M., Nozick, L. K., and Whitaker, L. R. (2002). Sizing the US destroyer fleet. *European Journal of Operational Research, 136*(3), 680-695.

Diakoulaki, D., Mavrotas, G., and Papayannakis, L. (1995). Determining objective weights in multiple criteria problems: The critic method. *Computers and operational research, 22*(7), 763-770.

Drezner, T., Drezner, Z., and Salhi, S. (2006). A multi-objective heuristic approach for the casualty collection points location problem. *The Journal of the Operational Research Society, 57*(6), 727-734.

Drezner, Z. (1995). *Facility location: A survey of applications and methods* (1st ed.). Springer Verlag New York, Inc.

Drezner, Z., and Wesolowsky, G. O. (2002). Network design: Selection and design of links and facility location. *Transportation Research Part A: Policy and Practice, 37*(3), 214-256.

Drobne S., Konjar M., and Lisec A. (2009). Delimitation of Functional Regions Using Labour Market Approach. In: ZadnikStirn L, Žerovnik J., Drobne S., Lisec A. (ed.). Proceedings of SOR'09, 10th International Symposium on Operational Research in Slovenia, Slovenian Society Informatika (SDI), Section for Operational Research (SOR), Ljubljana, Slovenia, pp. 417-425.

Dumais, G., Ellison, G., and Glaeser, E. L. (1997). Geographic concentration as a dynamic process. The Review of Economics and Statistics, 84(2), 193-204.

Eberts, R. W. (1991). Some empirical evidence on the linkage between public infrastructure and local economic development. In industry location and public policy. Knoxville: University of Tennessee Press.

Eckenrode, R. T. (1965). Weighting multiple criteria. *Management Science, 12*(3), 180-192.

Eitzen, G., Sier, D., and Singh, G. (2005). Optimal product mix for Murray Goulburn Cooperative, in the 18 th National ASOR Conference, eds. L Caccetta& V Rehbock, Perth, pp. 50-58.

Engberg, J., and Robert, G. (1999). State enterprise zones and local housing markets. *Journal of Housing Research, 10*(2).

Ertay, T., Ruan, D., and Tuzkaya, U. R. (2006). Integrating data envelopment analysis and analytic hierarchy for the facility layout design in manufacturing systems. *Information Sciences, 176*(3), 237-262.

Eshlaghy, A. T., and Farokhi, E. N. (2011). Measuring the Importance and the weight of decision makers in the criteria weighting activities of group decision making process. *American Journal of Scientific Research, (*23), 6-12.

Eskigun, E., Uzsoy, R., Preckel, P. V., Beaujon, G., Krishnan, S., and Tew, J. D. (2005). Outbound supply chain network design with mode selection, lead times and capacitated vehicle distribution centers. *European Journal of Operational Research, 165* (1), 182-206.

Farahani, R.Z. and Hekmatfar, M. (2009). *Facility location: Concepts, models, algorithms and case studies*. Springer-Verlag Berlin Heidelberg, Germany.

Fisher, R.C. (1997). The effects of state and local public services on economic development. *New England Economic Review* (Mar), 53-82.

Fulton, W., and Paul, S. (2001). Little chips, big dreams. Governing.

Ghodsypour, S.H., and O'Brien, C. (1998). A decision support system for supplier selection using an integrated analytic hierarchy process and linear programming. *International Journal of Production Economics, 56*(1), 199-212.

Goodstein, E. (1999). *The trade-off myth: Fact and fiction about jobs and the environment*(1st ed.). Washington, D.C.: Island Press.

Grabisch, M. (1996). The application of fuzzy integrals in multicriteria decision

making. *European Journal of Operational Research, 89*(3), 445-456.

Guo, L. S., and He, Y. S. (1999). Integrated multi-criterial decision model: A case study for the allocation of facilities in Chinese agriculture. *Journal of Agricultural Engineering Research 73*(1), 87-94.

Hajkowicz, S., Young, M., and MacDonald, D. H. (2000). Supporting decisions: Understanding natural resource management assessment techniques. *Natural Resource Management Economics.* Retrieved from http://ideas.repec.org/p/csi/report/00_003.html

Hansen, P.,Peeters, D., and Thisse, J. (1997). Facility location under zone pricing. *Journal of Regional Science, 37*(1), 1-22.

Hanumaiah, N., Ravi, B., and Mukherjee, N. P. (2006). Rapid hard tooling process selection using QFD-AHP methodology. *Journal of Manufacturing Technology Management 17*(3), 332-350.

Harvard Business School. (1989). Note on facility location, publishing division. Harvard Business School, Boston, MA.

Helms, J. L. (1985). The effects of state and local taxes on economic growth: A time series-cross section approach. *Review of Economic and Statistics, 67*(4) 574-582.

Ho, W. (2007). Integrated analytical hierarchy process and its applications- literature review. *Journal of operational research, 186*(1), 211-228.

Hsiao, S. W. (2002). Concurrent design method for developing a new product. *International Journal of Industrial Ergonomics, 29*(1), 41-55.

Hurtado, V. S., and Toussaint, G. T. (2000). Some constrained minmax and maxmin location problems. Studies in location analysis, special issue on computational Geornetry in location analysis. Guest Editor: Juan Mesa. Issue No. 15, December 2000, pp. 17-35.

Hwang, C.L., and Yoon, K. (1981). *Multiple attribute decision making: Methods and applications: A state-of-the-art survey*. Springer, New York.

Hwang, H. C., Chang, S. Y. and Park, S. (2005). A two dimensional vector packing model for the efficient use of oil cassettes. *Computers and Operations Research, 32*, 2051-2058.

Ignizio, J. P., and Cavalier T. M. (1994). Linear Programming. Paperback, Facsimile.

Ishizaka A.,and Labib A. (2011). Review of the main developments in the analytic hierarchy process. *Expert Systems with Applications, 38*(11), 14336-14345.

Isiklar, G., &Buyukozkan, G. (2006). Using multi-criteria decision making approach to evaluate mobile phone alternatives. *Computer Standards and Interfaces, 29*(2), 265-274.

Jaffe, A.B., Peterson, S.R., Portney, P.R., & Stavins, R.N. (1995). Environmental regulation and the competitiveness of U.S. manufacturing: What does the evidence tell us? *Journal of Economic Literature*, 33(1), 132-163.

Jayaraman, V. (1998). Transportation, facility location and inventory issues in distribution network design: An investigation. *International Journal of Operations & Production Management, 18*(5),471-494.

Jia, J., Fischer, G.W., and Dyer, J.S. (1997). Attribute weighting methods and decision quality in the presence of response error: Assimilation study. *Journal of Behavioural Decision Making*, in press.

Johnson, E. M., and Huber, G. P. (1977). The technology of utility assessment. *IEEE Systems, Man, and Cybernetics, 7*(5), 311-325.

Judice, J., Matins, P., and Nunes, J. (2005). Workforce planning in a lotsizing mail processing problem. *Computer & Operations Research, 32*(11) 3031-3058.

Kajanus, M., Kangas, J.,and Kurttila, M. (2004). The use of value focused thinking and the A'WOT hybrid method in tourism management. *Tourism Management, 25*(4), 499-506.

Kearns, G. S. (2004). A multi-objective, multi-criteria approach for evaluating IT investments: Results from two case studies. *Information Resources Management Journal, 17*(1), 37–62.

Kim, A. D., Partee, N., Reynolds, T. J., and Santamaria, M. A. (2002). Patent litigation risk scoring model. Working paper. University of Virginia.

Kim, D. J., Song, K. H., Chung, S. B., and Hong, S. Y. (2005). Development of an assessment model using AHP technique for railroad projects experiencing severe conflicts in Korea. *Proceedings of the eastern Asia society for transportation studies, 5*(), 2260-2274.

Kim, P.O., Lee, K.J., and Lee, B. W. (1999). Selection of an optimal nuclear fuel cycle scenario by goal programming and the analytic hierarchy process.

Annals of Nuclear Energy, 26(5), 449-460.

Klose, A.,and Gortz, S. (2007). A branch-and-price algorithm for the capacitated facility location problem. *European Journal of Operation Research 179*(3), 1109-1125.

Koksal, G., and Egitman, A. (1998). Planning and design of industrial engineering education quality. *Computers and Industrial Engineering, 35*(3–4), 639-642.

Kong, F., and Liu, H. (2005). An algorithm for MADM based on subjective preference. *IFIP International Federation for Information Processing, 187*(2005), 279-289.

Korpela, J., Kylaheiko, K., Lehmusvaara, A., and Tuominen, M. (2002). An analytic approach to production capacity allocation and supply chain design. *International Journal of Production Economics, 78*(2), 187-195.

Korpela, J., and Lehmusvaara, A. (1999). A customer oriented approach to warehouse network evaluation and design. *International Journal of Production Economics, 59*(1–3), 135-146.

Korpela, J., Kylaheiko, K., Lehmusvaara, A., and Tuominen, M. (2001). The effect of ecological factors on distribution network evaluation. *International Journal of Logistics: Research and Applications, 4*(2), 257-269.

Korpela, J., Lehmusvaara, A., and Tuominen, M. (2001).Customer service based design of the supply chain. *International Journal of Production Economics, 69*(2), 193-204.

Krajewski, L.J., and Ritzman, L. P. (1993). *Management of conversion system: Facility location, operations management strategy and analysis*. Prentice Hall.

Kumar, S., Parashar, N., and Haleem, A. (2009). Analytical hierarchy process applied to vendor selection problem: Small scale, medium scale and large scale industries. *Business Intelligence Journal, Vol. 2*(2), 355-362.

Kumral, M. (2004). Optimal location of a mine facility by genetic algorithms. *Mining Technology, 113*(2), 83-88.

Kuo, R.J., Chi, S.C., and Kao, S. S. (2002). A decision support system for selecting convenience store location through integration of fuzzy AHP and artificial

neural network. *Computers in Industry, 47*(2), 199-214.

Kurttila, M., Pesonen, M., Kangas, J., and Kajanus, M. (2000). Utilizing the analytic hierarchy process (AHP) in SWOT analysis – A hybrid method and its application to a forest certification case. *Forest Policy and Economics, 1*(1), 41-52.

Kwak, N. K., and Lee, C. W. (1998). A multicriteria decision-making approach to university resource allocations and information infrastructure planning. *European Journal of Operational Research, 110*(2), 234–242.

Kwak, N.K., and Lee, C. W. (2002). Business process reengineering for health-care system using multicriteria mathematical programming. *European Journal of Operational Research, 140*(2), 447-458.

Kwak, N.K., Lee, C.W., and Kim, J. H. (2005). An MCDM model for media selection in the dual consumer/industrial market. *European Journal of Operational Research, 166*(1), 255-265.

Kwong, C.K., and Bai, H. (2002). A fuzzy AHP approach to the determination of importance weights of customer requirements in quality function deployment. *Journal of Intelligent Manufacturing, 13*(5), 367-377.

Kwong, C.K., and Bai, H. (2003). Determining the importance weights for the customer requirements in QFD using a fuzzy AHP with an extent analysis approach. *IIE Transactions, 35*(7), 619-626.

Lam, K., and Zhao, X. (1998). An application of quality function deployment to improve the quality of teaching. *International Journal of Quality and Reliability Management, 15*(4), 389-413.

Lamata, M. T., and Pelaez, J. I. (2002). A method for improving the consistency of judgements. *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, 10*(6), 677-686.

Lee, C.E., and Hsu, S. C. (2004). Outsourcing capacity planning for an IC design house. *International Journal of Advanced Manufacturing Technology, 24*(3–4), 306-320.

Lee, C.W., and Kwak, N. K. (1999). Information resource planning for a health-care system using an AHP-based goal programming method. *Journal of the Operational Research Society, 50*(12), 1191-1198.

Lesmes, D., Castillo, M., and Zarama, R. (2009). Application the Analytic Network Process (ANP) to establish weights in order to re-accredit a program of a university. Proceedings of the International Symposium on the Analytic

Hierarchy Process.

Li, H. F. and Wang, J. J. (2007), An improved ranking method for ELECTRE III. Retrieved 10 April 2011 from http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=04341409.

Liberatore, M. J., and Nydick, R. L.(1997). Group decision making in higher education using the analytical hierarchy process. *Research in Higher Education, Vol. 38*(5), 593-597.

Liberatore, M. J., and Nydick, R. L. (2008). The analytic hierarchy process in medical and health care decision making: A literature review. *European Journal of Operational Research, 189*(1), 194-207.

Lin, D.,Pei, J., Ma, J., and Lee, D. L. (2004). A rank sum test method for informative gene discovery. Industry/government track paper, 410-419.

Liu, L. (2000). Labor location and agricultural land use in Jilin, China. *The Professional Geographer, 52*(1), 74-83.

Liu, L. B., Berger, P., Zeng, A., and Gerstenfeld, A. (2008). Applying the analytic hierarchy process to the offshore outsourcing location decision. *Supply Chain Management, 13*(6), 435-440.

Ma, J., Fan, Z. P., and Huang, L. H. (1999). A subjective and objective integrated approach to determine attributes weights. *European Journal of Operational Research, 112*(2), 397-404.

MacCormak, A. D, Lawrence, J,N., and David, B.R. (1994). The new dynamics of global manufacturing site location. *Sloan Management Review*. Pp. 69-77.

Macharis, S.C., Springael, J., De Brucker, K., and Verbeke, A. (2004). PROMETHEE and AHP: the design of operational synergies in multicriteria analysis: Strengthening PROMETEE with ideas of AHP. *European Journals of operational Research, 153*(2), 307-317.

Madu, C. N., Kuei, C., and Madu, I. E. (2002). A hierarchic metric approach for integration of green issues in manufacturing: A paper recycling application. *Journal of Environmental Management, 64*(3), 261-272.

Mahmoodzadeh, S., Shahrabi, J., Pariazar, M., and Zaeri, M. S. (2007). Project selection by using fuzzy AHP and TOPSIS technique. *World Academy of Science, Engineering and Technology 30*.

Maidamisa, A.A, Ahmad, R., and Ismai, A.M. (2012). Selecting the appropriate decision alternatives using SM and AHP. *International Journal of Computer Applications,37*(10), 14-18.

Malczewski, J., Moreno-Sanchez, R., Bojorquez-Tapia, L.A., and Ongay-Delhumeau, E. (1997). Multicriteria group decision-making model for environmental conflict analysis in the Cape Region, Mexico. *Journal of Environmental Planning and Management, 40*(3), 349-374.

Malladi, S., and Min, K.J. (2005). Decision support models for the selection of internet access technologies in rural communities. *Telematics and Informatics, 22*(3), 201-219.

Marianov, V., and ReVelle, C. (1992). The queuing maximal availability location problem: A model for the siting of emergency vehicles.*European Journal of Operational Research, 93*(1), 110-120.

Masozera, M.K., Alavalapati, J.R.R., Jacobson, S.K., and Shrestha, R. K. (2006). Assessing the suitability of community-based management for the Nyungwe Forest Reserve, Rwanda. *Forest Policy and Economics, 8*(2), 206-216.

Maznah Mat Kasim. (2008). Determination of criteria weight in multi criteria problem. PhD thesis, Universiti Kebangsaan Malaysia, Bangi, Selangor Malaysia.

Millet, I., and Wedley, W. C. (2002). Modelling risk and uncertainty with the analytic hierarchy process. *Journal of Multi−Criteria Decision Analysis*, *11*(2), 97−107.

Min, H.,and Melachrinoudis, E. (2001). The three hierarchical location allocation of banking facilities with risk and uncertainty. *International Transactions in Operational Research, 8*(4), 381-401.

Ministry of Agriculture and Irrigation. (2009). Agricultural guidelines for Hadhramout province. Sana'a, Yemen.

Mohammad, R.B. (2005). Development of a model for the selection of dispute resolution method. Unpublished master thesis, King Fahd University of Petroleum and Minerals, Saudi Arabia.

Mohd Armi, Latifah, Wan Nor AzminSulaiman and Rafikul Islam (2007). Application of the analytical hierarchy process (AHP) for selecting an appropriate solid waste treatment technology. 2nd national intelligent systems

and information technology symposium (ISITS'07), Oct 30-31.

Moored B., Garrod N., and Briggs G. (1978). The student nurse allocation problem: A formulation. *Omega, 6*(1), 93-6.

Murphy, C. K. (1993). Limits on the analytic hierarchy process from its consistency index. *European Journal of Operational Research, 65*(1), 138-139.

Musa A. A., and Saxena U. (1984). Scheduling nurses using goal programming techniques. *IIE Transactions, 16*(3), 217-21.

Myint, S., (2003). A framework of an intelligent quality function deployment (IQFD) for discrete assembly environment. *Computers and Industrial Engineering, 45*(2), 269-283.

Obad, S., Hassan, A., Alhabshi, K., Bin-Hadjeh, A.,and Albaar, A. (2003). Field survey results to date palm varieties in the province of Mahra. Centre of agriculture and research, Seyuon.

Ogryczak, W. (2008). Fair and efficient resource allocation: Bicriteria models for equitable optimization. International Conference on Informatics in Control, Automation and Robotics.

Okabe, A., Boots, B., and Sugihara, K. (1992).*Spatial tessellations: Concepts and applications of voronoi diagrams.* John Wiley Sons, Chichester. UK.

Ozdemir, M.S., and Gasimov, R. N., (2004). The analytic hierarchy process and multiobjective 0–1 faculty course assignment. *European Journal of Operational Research, 157*(2), 398-408.

Özkan, B., Başlıgil, H., and Şahin, N. (2011). Supplier selection using analytic hierarchy process: An application from Turkey. Proceedings of the World Congress on Engineering. Vol II WCE 2011, July 6 - 8, 2011, London, U.K.

Özkan,B., Başlıgil, H., and Özen, O. (2011). Choosing concrete production facility location using AHP and TOPSIS methodologies. 15th international research/expert conference "Trends in the Development of Machinery and Associated Technology" TMT 2011, Prague, Czech Republic.

Pacheco, J., and Casado, S. (2004). Solving two location models with few facilities by using a hybrid heuristic: A real health resources case. *Computers and Operations Research, 32*(12), 3075-3091.

Partovi, F. Y. (1999). A quality function deployment approach to strategic capital budgeting. *The Engineering Economist, 44*(3), 239-260.

Partovi, F. Y. (2006). An analytic model for locating facilities strategically. *Omega, 34*(1), 41-55.

Partovi, F.Y., and Corredoira, R. A. (2002). Quality function deployment for the good of soccer. *European Journal of Operational Research, 137*(3), 642-656.

Partovi, F. Y., and Epperly, J. M. (1999). A quality function deployment approach to task organization in peacekeeping forcedesign. *Socio-Economic Planning Sciences, 33*(2), 131-149.

Percin, S. (2008). Using the ANP approach in selecting and benchmarking ERP systems. *Journal of Benchmarking, 15*(5), 630-649.

Phillips, J. M, and Ernest, T. G. (1995). The effect of state and local taxes on economic development. *Southern Economic Review 62*(2), 320-333.

Poyhonen, M., and Hamalainen, P. R. (2001). On the convergence of multi-attribute weighting methods. *European Journal of Operational Research, 129*(3), 569-585.

Radasch, D.K., and Kwak, N. K. (1998). An integrated mathematical programming model for offset planning. *Computers and Operations Research, 25*(12), 1069-1083.

Radcliffe, L.L., and Schniederjans, M. J. (2003). Trust evaluation: An AHP and multi-objective programming approach. *Management Decision, 41*(6), 587-595.

Rafikul Islam. (2007). MBNQA criteria in education: Assigning weights from a Malaysian perspective and proposition for an alternative evaluation scheme. *International transactions in operational research, 14*(5), 373-394.

Rafikul Islam, and Rasad, S. (2005). Employee performance evaluation by AHP : A case study. Retrieved on 3 February 2009 from http://www.isahp.org/2005 proceedings/ papers/islamR_Rasademployeeperformanceevaluation.pdf.

Ramanathan, R. (2001). A note on the use of the analytic hierarchy process for environmental impact assessment. *Journal of Environmental Management, 63*(1), 27-35.

Revelle, C.S., and Eiselt, H.A. (2005). Location analysis: A synthesis and survey. *European Journal of Operational Research, 165*(1), 1-19.

Roberts, R., and Goodwin, P. (2003). Weight approximations in multi attribute decision models. *Journal of Multi Criteria Decision Analysis, 11*(6), 291-303.

Rosing, K., Hillsman, E., and Rosing-Vogelaar, H. (1979). The robustness of two common heuristics for the P-median problem. *Environment and Planning, 11*(4), 373-380.

Saaty T. L., and Vargas, L. G. (2001). *Models, methods, concepts and applications of the analytic hierarchy process.* Kluwer, Dordrecht.

Saaty, T.L. (1980). *The analytic hierarchy process*. New York: McGraw-Hill.

Saaty, T.L. (1988). Decision making, scaling, and number crunching. *Decision sciences, 20*(2), 404-409.

Saaty, T. L. (1990). *Multicriteria Decision Making: The analytic hierarchy process*.Pittsburg: RWS Publications.

Saaty, T. L. (1995).*Decision making for leaders: the analytic hierarchy process for decision in a complex world* (3rd ed.). RWS Publications, USA.

Saaty, T. L. (1999). *Decision making for leaders: The analytic hierarchy process for decisions in a complex world*. RWS Publications, USA.

Saaty, T. L., and Peniwati, K. (2008).*Group decision making: Drawing out and reconcilingdifferences.*Pittsburg: RWS Publications.

Saaty, T.L., Vargas, L.G., and Dellmann, K. (2003). The allocation of intangible resources: The analytic hierarchy process and linear programming. *Socio-Economic Planning Sciences, 37*(3), 169-184.

Saaty, T.L. (1994). *Fundamentals of decision making and priority theory with the analytic hierarchy process*.Pittsburg: RWS Publications.

Saeid, M., Abdul Azim, A. G., and Mohd Hasan, S. (2011). Rank-order weighting of web attributes for website evaluation. *The International Arab Journal of Iformation Technology*, 8(1), 30-38

Saen, R. F., Memariani, A., and Lotfi, F. H. (2005). Determining relative efficiency of slightly non-homogeneous decision making units by data envelopment analysis: A case study in IROST. *Applied Mathematics and Computation, 165*(2), 313-328.

Schniederjans, M. J., and Garvin, T. (1997). Using the analytic hierarchy process and multi-objective programming for the selection of cost drivers in activity-based costing. *European Journal of Operational Research, 100*(1), 72-80.

Schniederjans, M. J., Kwak, N. K., and Helmer, M. C. (1982). An application of goal programming to resolve a site location problem. *Interfaces, 12*(3), 65-72.

Schreiner, M. (2000). Credit scoring for microfinance: Can it work. *Journal of Microfinance. 2*(2), 105–118.

Shinno, H., Yoshioka, H., Marpaung, S., and Hachiga, S. (2006). Quantitative SWOT analysis on global competitiveness of machine tool industry. *Journal of Engineering Design, 17*(3), 251-258.

Shrestha, R. K., Alavalapati, J. R. R., and Kalmbacher, R. S. (2004). Exploring the potential for silvopasture adoption in south-central Florida: An application of SWOT-AHP method. Agricultural Systems 81 (3), 185–199.

Srivastava, J., Connolly, T., and Beach, L. R. (1995). Do ranks suffice? Acomparison of alternative weighting approaches in value elicitation. *Organizational Behavior and Human Decision Processes, 63*(1), 112-116.

Stannard, B., and Zahir, S. (2006). Application of analytic hierarchy process in multi-objective mixed integer programming for aircraft capacity planning. *Asia-Pacific Journal of Operational Research, 23*(1), 61-76.

Stein, W. E., and Mizzi, P. J. (2006).The harmonic consistency index for the analytic hierarchy process. *European Journal of Operation Research, 177*(1), 488-457.

Stevenson, W. J., and Ozgur, C. (2007). *Introduction to management science with spreadsheets*. Boston: McGraw Hill.

Syamsuddin, I., and Hwang, T. (2009). The application of AHP to evaluate information security policy decision making. *International Journal of Simulation, Systems, Science & Technology, 10*(5), 33-37.

Ta, H.P., and Har, K.Y. (2000). A study of bank selection decisions in Singapore using the analytic hierarchy process. *International Journal of Bank Marketing, 18*(4)170-180.

Taha, H. A. (2008). *Operations research: An introduction* (8^{th} ed.). Prentice Hall.

Tahriri, F., Osman, M.R., Ali, A., Yusuff, R., and Esfandiary, A. (2008). AHP approach for supplier evaluation and selection in a steel manufacturing company. *Journal Of Industrial Engineering and Management, 1*(2), 54-76.

Takamura, Y., and Tone, K. (2003). A comparative site evaluation study for relocating Japanese government agencies out of Tokyo. *Socio-Economic Planning Sciences 37*(2), 85-102.

Tamiz, M., Jones, D., and Mirrazavi, S. K. (2002). Multi-objective meta-heuristics: An overview of the current state-of-the-art. *European Journal of Operational Research, 137*(1), 1-9.

Tannenwald, R. (1997). State regulatory policy and economic development. *New England Economic Review, 1997*(Mar), 83-99.

Taylor, B. W. (2004). *Introduction to management science* (8th ed.). New Jersey: Pearson Prentice Hall.

Taylor, B. W. (2010). *Introduction to Management Science* (10th ed.). Boston: Pearson.

Triantaphyllou, E. (2001). Two new cases of ranking reversals when the AHP and some of its additive variants are used that do not occur with the multiplicative AHP. *Multi-Criteria Decision Analysis, 10*(), 11-25.

Trivedi V. M. (1981). A mixed integer goal programming model for nurse service budgeting. *Operations Research, 29*(5), 1019-1034.

Tyagi, R., and Das, C. (1997). A methodology for cost versus service trade-offs in wholesale location-distribution using mathematical programming and analytic hierarchy process. *Journal of Business Logistics, 18*(2), 77-99.

Van Den Hornert, R. C.,and Lootsa, F. A. (1996). Group preference aggregation in the multiplicative AHP: The model of the group decision process and Pareto optimality. *European Journal of operation research, 96*(2), 363-370.

Wagholikar, A. S. (2007). An approach to improve practical application of fuzzy measures in multi-criteria decision making. Paper presented in NAFIPS International Conference, Griffith University.

Wagholikar, A. S., and Deer, P. (2007). Fuzzy measures acquisition methods. *Engineering Letters (IAENG), 14*(2), 56-60.

Wang, G., Huang, S. H., and Dismukes, J. P. (2004). Product-driven supply chain selection using integrated multi-criteria decision- making methodology. *International Journal of Production Economics, 91*(1),1–15.

Wang, X., and Regan, A. C. (2000). Local truckload pickup and delivery with hard time window constraints. *Transportation Research Part B: Methodological, 36*(2), 97-112.

Wang, Y.M., Yang, J.B., and Xu, D. L. (2006). Environmental impact assessment using the evidential reasoning approach. *European Journal of Operational*

Research, 174(3), 1885–1913.

Wang, Y., and Elhag T.M.S. (2006). Fuzzy TOPSIS method based on alpha level sets with an application to bridge risk assessment. *Expert Systems with Applications, 31*(2), 309-319.

Wasner, M., and Zapfel, G. (2004). An integrated multi depot hub location vehicle routing model for network planning of parcel service. *International Journal of Production Economics,90*(3), 403-419.

Wasylenko, M. (1997). Taxation and economic development: The state of the economic literature. *New England Economic Review, 1997*(Mar), 37-52.

Williams, T. (2008). *Management science in practice*. John Wiley & Sons, Ltd.

Xu, D.L., Yang, J.B., and Wang, Y. M. (2006). The ER approach for multi-attribute decision analysis under interval uncertainties. *European Journal of Operational Research, 174*(3).

Xu, X. (2004). A note on the subjective and objective integrated approach to determine attributes weights. *European Journal of Operational Research, 156*(2), 530-532.

Yang, J., and Lee, H. (1997). An AHP decision model for facility location selection. *Facilities, 15*(9/10), 241-254.

Yang, T., and Kuo, C. (2003). A hierarchical AHP/DEA methodology for the facilities layout design problem. *European Journal of Operational Research, 147*(1), 128-136.

Yeh, C. H., Willis, R. J., Deng, H., and Pan, H. (1998). Task oriented weighting in multi-criteria analysis. *European Journal of Operational Research, 119*(1), 130-146.

Yurdakul, M. (2004). Selection of computer-integrated manufacturing technologies using a combined analytic hierarchy process and goal programming model. *Robotics and Computer-Integrated Manufacturing, 20* (4), 329-340.

Zaeri, M. S., Sadeghi, A., Naderi, A., Kalanaki, A., Fasihy, R., Shorshani, S. M. H., and Poyan, A. (2011). Application of multi criteria decision making technique to evaluation suppliers in supply chain management. *African Journal of Mathematics and Computer Science Research, 4*(3), 100-106.

Zahir, S. (1999). Clusters in group: Decision making in the vector space formulation of the analytic hierarchy process. *European Journal of Operational Research,*

112(3), 620-634.

Zakarian, A., and Kusiak, A. (1999). Forming teams: An analytic approach. *IIE Transactions, 31*(1), 85-97.

Zeshui, X. (2004). A practical method for improving consistency of judgement matrix in the AHP. *Journal of Systems Science and Complexity, 17*(2), 169-175.

Zheng, G., Zhu, N., Tian, Z., Chen, Y., and Sun, B. (2012). Application of a trapezoidal fuzzy AHP method for work safety evaluation and early warning rating of hot and humid environments. *Safety Science, 50*(2), 228-239.

Zhou, Z., Cheng, S., and Hua, B. (2000). Supply chain optimization of continuous process industries with sustainability considerations. *Computers and Chemical Engineering, 24* (2–7), 1151-1158.