UNIVERSITI PUTRA MALAYSIA

APPLICATION OF GEOSPATIAL MULTIPLE CRITERIA DECISION ANALYSIS IN SITING COMBINED CYCLE POWER PLANT IN IRAN

SIAVASH EGHBALI

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APPLICATION OF GEOSPATIAL MULTIPLE CRITERIA DECISION ANALYSIS IN SITING COMBINED CYCLE POWER PLANT IN IRAN

By

SIAVASH EGHBALI

Thesis submitted to the school of graduate studies, Universiti Putra Malaysia, in fulfilment of the requirement for the Degree of Master of Science

March 2011

Especially dedicated to:

My beloved family, my teachers, and my friends

Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman: Associate Professor Ahmad Rodzi Mahmud, PhD

Faculty : Institute of Advanced Technology

Establishment of a power plant as a main infrastructure requires comprehensive investigation prior to construction phase. Location of power plant is one of the main issues which should be inspected in advance to guarantee its future optimized operation and minimized losses. This study uses the integration of Geographic Information System (GIS) and Multi Criteria Decision Analysis (MCDA) approach to site a Combined Cycle Power Plant (CCPP). This research was implemented in three successive stages which include a small scale map (1:250,000) and a large scale map (1:25,000) site suitability assessments, and a site selection. In the first stage, a site suitability assessment was performed to determine the high potential area in Sistan and Baluchistan province in Iran for CCPP establishment using small scale map (1:250,000). This stage involves a number of processing steps which include: definition of influential siting criteria, relative classification and constraint zones determination, evaluation criteria prioritization (PWC method) and factor maps integration (WLC method). The final

result of this stage showed that around 0.03% of province area possesses the highest potential for CCPP establishment. After imposing constraint map, it was found that the north zone of Chabahar port is the only most potential area which is feasible for CCPP construction. In next stage, based on the highest potential area of 1:250,000 scale analysis, the same steps of site suitability assessment were implemented to obtain the highest potential regions using 1:25,000 scale map. The result illustrates that around 12% of study area had the highest potential for CCPP establishment. Afterward, by imposing final constraint map and CCPP areal limitation, 3 alternatives were designed as final candidate sites for CCPP establishment. In the final stage, a spatial decision making was performed to determine the best site for CCPP placement and the result shows that Site 1 is the best site for its establishment. For evaluating the robustness of final result, a sensitivity analysis was performed based on two criteria weights as the most controversial. The sensitivity analysis results confirmed the persuasive stability of final result against perturbation in criteria weights. The experts' opinions in all stages agreed on high importance of water and fuel provision in locating the CCPP establishment site. Also the measuring index for the load demand criterion which is the load demand growth in previous studies emerged incomplete and was replaced by the load demand density.

Abstrak tesis dikemukakan kepada Senat Universiti Putra Malaysia untuk memenuhi keperluan ijazah Master Sains

PENGGUNAAN ANALISIS KEPUTUSAN PELBAGAI KRITERIA GEOSPATIAL BAGI PENENTUAN LOKASI PEMBINAAN LOJI KUASA KITARAN BERGABUNG DI IRAN

oleh

SIAVASH EGHBALI

Mac 2011

Pengerusi: Profesor Madya Sr. Ahmad Rodzi Mahmud, PhD

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Pembinaan loji kuasa sebagai infrastruktur utama memerlukan kajian menyeluruh sebelum proses pembinaan dimulakan. Lokasi loji kuasa merupakan salah satu isu utama yang harus diselidiki terlebih dahulu untuk memastikan operasi pada masa hadapan dapat dioptimumkan dan kerugian dapat diminimumkan. Kajian ini menggunakan kerangka bersepadu antara Sistem Maklumat Geografi (Geographic Information System - GIS) dan pendekatan Analisis Keputusan Pelbagai Kriteria (Multi Criteria Decision Analysis - MCDA) bertujuan menentukan tapak untuk mendirikan Loji Kitaran Kuasa Bergabung (Combined Cycle Power Plant - CCPP). Penyelidikan ini dilaksanakan pada tiga tahap secara berurutan, iaitu melibatkan peta skala kecil (1:250.000) bagi penilaian kesesuaian tapak loji, dan peta skala besar (1:25,000) bagi penilaian kesesuaian dan pemilihan tapak loji. Pada tahap pertama, penilaian kesesuaian tapak dilakukan untuk menentukan kawasan yang berpotensi tinggi di wilayah Sistan untuk mewujudkan CCPP. Tahap ini merangkumi beberapa langkah pemprosesan,

meliputi tafsiran kriteria penentuan tapak yang positif, zon dalam klasifikasi relatif dan kendalaan, penilaian kriteria keutamaan (kaedah PWC), dan faktor integrasi pemetaan (kaedah WLC). Keputusan akhir pada tahap ini menunjukkan bahawa kira-kira 0.03% kawasan wilayah mempunyai potensi tertinggi untuk mendirikan CCPP. Setelah mengambil kira petunjuk kendala, didapati bahawa zon utara pelabuhan Chabahar merupakan satu-satunya daerah yang paling berpotensi untuk mendirikan CCPP. Pada tahap seterusnya, dengan menggunakan daerah berpotensi tertinggi yang ditentukan pada tahap sebelumnya, langkah yang sama bagi penilaian kesesuaian tapak telah dilaksanakan untuk mendapatkan kawasan yang berpotensi tertinggi pada peta berskala 1:25,000. Keputusan ini menunjukkan bahawa 12% daerah kajian mempunyai potensi tertinggi bagi pembinaan CCPP. Setelah itu, petunjuk akhir kendalaan dan keterbatasan kawasan CCPP diambil kira, dan didapati bahawa tiga alternative telah dicadangkan sebagai tapak untuk pilihan akhir bagi pembinaan CCPP. Pada tahap akhir, proses membuat keputusan dilakukan untuk menentukan lokasi terbaik untuk mendirikan CCPP dan hasilnya menunjukkan bahawa Tapak 1 merupakan tapak terbaik untuk pembinaannya. Untuk menilai kekukuhan keputusan akhir, analisis sensitiviti dilakukan terhadap dua kriteria yang dianggap sebagai yang paling kontroversial. Keputusan analisis sensitiviti mengesahkan bahawa kriteria kestabilan bagi keputusan akhir yang diragui mengatasi kriteria gangguan. Para pakar dalam semua tahap sependapat bahawa kesediaadaan pembekalan air dan bahan bakar yang tinggi penting dalam mencari tapak pembinan CCPP. Juga indeks pengukuran berdasarkan kriteria jumlah permintaan yang bergantung pada peningkatan jumlah permintaan dalam kajian dahulu ternyata tidak lengkap dan harus digantikan dengan kepadatan jumlah permintaan.

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I certify that a Thesis Examination Committee has met on 1 March 2011 to conduct the final examination of Siavash Eghbali on his thesis entitled "Application of Geospatial Multiple Criteria Decision Analysis in Siting Combined Cycle Power Plant in Iran" in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

SIAVASH EGHBALI

Date:

TABLE OF CONTENTS