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

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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.

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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

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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

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