



UNIVERSITI PUTRA MALAYSIA

***DEVELOPMENT OF A MULTI-OBJECTIVE OPTIMIZATION MODEL
FOR TRANSPORT AND ENVIRONMENT IN A CLOSED-LOOP
AUTOMOTIVE SUPPLY CHAIN***

ABDOLHOSSEIN SADRNIA

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By

ABDOLHOSSEIN SADRNIA

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfillment of the Requirements for the Degree of Doctor of Philosophy**

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**With love and gratitude to my Parents , my wife, Marzieh
and my children and.**



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Abstract of thesis to be presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Doctor of Philosophy

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Due to increasing severity of the environment such as limited raw materials, increasing pollutions, global warming and greenhouse gas (GHG) pollution, manufacturers have to design their supply chains to be green. For example, greening the automotive supply chain has become a major concern and car manufacturers have been obliged to recover at least 95% End-Of-Life vehicle (ELV) by 2015. Since closed-loop network make an infrastructure to collect and recover used products, developing an effective closed-loop network as a major greening tool in supply chains has been growing increasingly by researchers.

Most researchers have tried to minimize the total cost in logistics network and neglects environmental while the most important question in green supply chain is how to identify preferred solutions balancing environmental and business concerns. Since the logistics networks are known as complex models, exact methods could not find the optimum solution. Therefore, various meta-heuristic algorithms have been tried by researchers.

In this research, a new Multi-Objective Logistics Network Model for Automotive Closed-Loop Supply Chain (MOACLSC) for recovering ELVs was developed. After that a Meta-heuristic method is used for finding the global optimum solution. The methodology of this research includes three stages. The variable (such as truck type for transportation and the amount of material that should be transhipped between facilities) and parameters (such as transportation cost, facilities' capacity) are identified and then the conceptual model for MOACLSC was developed. In the second stage, the MOACLSC mathematical model was developed for recovering ELVs. In the last stage, an extended Gravitational Search Algorithm (GSA) as a parallel search algorithm and high convergence rate into high quality final solutions is used to solve the proposed mathematical model and to achieve the Pareto set of solution. The Multi-objective GSA (MOGSA) algorithm is adopted and then programmed using MATLAB software particularly to the MOACLSC.

To verify the model, four examples from literature were considered and compared the MOGSA's optimum solutions result by Genetic Algorithm's (GA) result. The results obtained from problem were analyzed based on the objective function (cost), and the design parameters of the network. Analysis of results expressed the acceptable

performance of MOACLSC and MOGSA compared to the proposed mathematical model in the example and GA. Comparing the total cost of the networks, revealed that the total closed-loop logistics network's cost for ELV recovering were reduced by 1.7%, 2.4%, 3.3% and 3.9% in four problems respectively. Finally to present the model validity of a real case study in automotive industrial was studied. The result shows if the proposed model implement to redesign forward logistics, 12.36% of the total cost can be decreased. Indeed, a Pareto set of solutions including, 15 solutions were found which they can be selected a preferred solution balancing environmental and business concerns. To know the proposed model's sensitivity, after model validation, sensitivity analysis has been done and the result has been interpreted to provide some interesting managerial insights.



Abstrk tesis dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PEMBANGUNAN MODEL PENGOPTIMUMAN MULTI-OBJEKTIF
UNTUK PENGANGKUTAN DAN PERSEKITARAN DALAM RANTAIAN
TERTUTUP LOOP AUTOMOTIF BEKALAN**

Oleh

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Oleh kerana tahap peningkatan alam sekitar seperti bahan-bahan mentah dan sumber, meningkatkan pencemaran dan pelupusan yang melimpah, pemanasan global dan pencemaran gas rumah hijau (GHG), penghijauan rantai bekalan automotif telah menjadi keperluan utama supaya pengeluar kereta diwajibkan untuk mendapatkan semula sekurang-kurangnya 95% akhir hayat kenderaan (ELV) pada tahun 2015. Sejak infrastruktur suap-balik dan rangkaian logistik terbalik dalam memungut dan mendapat, menilai, mengilang semula dan mengitar semula produk yang digunakan untuk mencapai objektif, penyelidikan dan pengamal pembangunan suap-balik yang berkesan dan rangkaian logistik terbalik sebagai alat penghijauan utama dalam rantai bekalan telah semakin berkembang. Kebanyakan kajian pada masa sekarang telah cuba untuk mengurangkan jumlah kos dalam rangkaian logistik dan ini bermakna model selalunya dianggap sebagai objektif tunggal dan mengabaikan persekitaran dan objektif sosial. Manakala "rekabentuk" dalam kes sebenar biasanya melibatkan percanggahan objektif yang memerlukan tolak ansur dan keseimbangan.

Rangkaian logistik dikenali sebagai model kompleks, kaedah yang tepat tidak dapat mencari penyelesaian optimum, oleh itu masalah hijau begitu kompleks perlu pada pembangunan teknik-teknik moden dari pelbagai bidang saintifik. Salah satu kaedah pengoptimuman heuristik adalah *Gravity Search Algoritma (GSA)* yang dibina berdasarkan undang-undang graviti dan tanggapan interaksi massa.

Dalam kajian ini, model Multi-objektif Logistik Rangkaian baru telah dibangunkan untuk Rantai Automotif Bekalan suap balik (MOACLSC) untuk pemulihan ELVs. Algoritma GSA multi-objektif (MOGSA) diterima pakai dan kemudian diprogramkan menggunakan perisian MATLAB untuk MOACLSC. Dalam perbandingan rangkaian jumlah kos, ia adalah jelas bahawa kos jumlah gelung tertutup rangkaian logistik untuk pemulihan ELV telah menurun sebanyak 1.7% , 2.4 % , 3.3 % dan 3.9 % dalam empat masalah masing-masing. Akhir sekali untuk menentukan kesahihan model, kajian kes sebenar dalam industri automotif telah dilakukan. Hasilnya menunjukkan jika model yang dicadangkan itu dilaksanakan bagi reka bentuk semula logistik ke hadapan, 12.36 % daripada jumlah kos boleh dikurangkan. Malah, satu set Pareto penyelesaian termasuk 15 penyelesaian ditemui. Set keputusan boleh digunakan oleh pembuat keputusan.

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I certify that a Thesis Examination Committee has met on 16 July 2014 to conduct the final examination of Abdolhossein Sadrnia on his thesis entitled “Development of A Multi-Objective Optimization Model for Transport And Environment in a Closed-Loop Automotive Supply Chain” in accordance with the Universities and University Colleges 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 Doctor of Philosophy.

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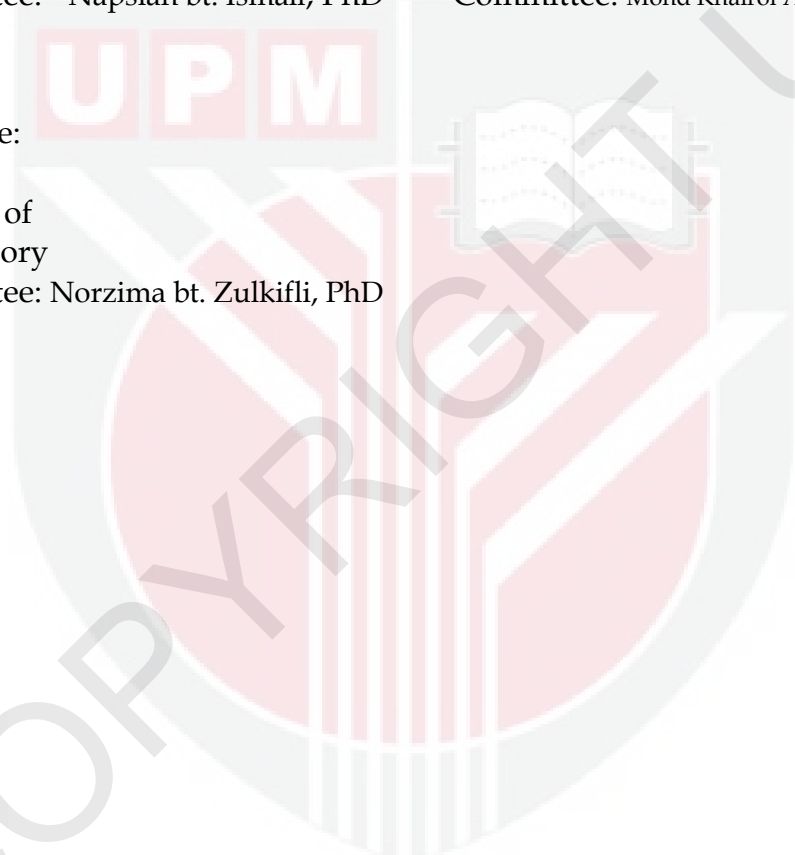


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