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Fuel Optimization Model in Reverse Logistics Network: A Case Study in Automobile Alternator Industrial

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Abstract. The previous assumptions that natural resources do not have limitation and that the regenerative capacity of the environment is able to compensate for all human action is no longer acceptable. Regarding to the issue, sustainability will be a crucial problem for the future generations. The logistics sector is a significant contributor to environmental damage and resource use. Not only companies are encouraged by environment regulation to be cautions to reuse used product but also they have understood that could be economic and beneficial if they can reuse product in end of life cycle. Reverse logistics network make an infrastructure to collect and recover, assess, remanufacture and recycle usedproducts to achieve the objective.Therefore, developing aneffectivereverselogisticsnetworkis more interesting by scholars and industrial researcher that to design supply chains to be more competitive specially when an enormous economic change is happening.It can be seen reverse and closed-loop logistics has been increasingly interesting by huge number of global and local companies to utilize economic profit. The main issue in designing reverse logistics is which and where facility should be considered in networks and how they have to relate together. In this research, a new optimized model developed to minimize fuel consumption in reverse logistics for gathering and recycling used automobile alternators in supply chain. Then, genetic algorithm as a meta-heuristics algorithm is applied to optimizedeveloped model.

Keywords: Sustainability, Optimization, fuel Saving, Energy Management, reverse logistic, product recover, green logistic

1. Introduction

Regarding to sustainability issues that will influence all organizational aspects of the human life, from the economical, political, social to environmental points of view. The reason is simple, until now, all human activities have been based on the paradigm of unlimited resources and unlimited world's capacity for regeneration.There are strong indications that we are moving from a world of abundant, cheap energy to a world of limited and expensive energy [1]. Energy use is an important indicator of overall environmental and resource impacts, especially sincetransportations sectors are quite dependent upon fossil fuels for energy. Hendrickson et al [2] analyzed the U.S. transportation service sectors of air, rail, water, truck, transit and pipeline in relation to economic impact, energy and GHG emissions. The study concluded that truck transportation is the most energy intensive of the transportation modes per ton-mile of service.

Over the last few decades, the focus of environmental impact has changed from the local to a global level. There is a consensus that rising temperature is contributing to disappearing glaciers and increasingly unstable weather patterns around the globe. It is well known that greenhouse gasses, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) raise the temperature near the surface of our planet [3]. The greenhouse gasses from transport and energy need to be addressed. Some companies are already trying to help the

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environment through the use of rail and depot consolidation. Under the Kyoto Protocol, the UK is now legally required to reduce greenhouse gas emissions by about 12.5 % by 2012.

In the last decades, regarding to supply chain complexity, Genetic Algorithm has been applied to optimize numerous problems in supply chain and find the optimized solution and configuration. Min et al. presented genetic algorithm application to developing the multi-echelon reverse logistics network for collecting used products[4]. Kannan et al presented a Genetic Algorithm based system for optimizing closed loop logistic to battery recovery[5]. Ko et al. developed a mixed integer nonlinear programming model for the design of a dynamic integrated distribution network for 3PLs. they used genetic algorithm to handle the realistically sized problem presented [6].

This paper covers new infrastructure modeling determines the optimum transportation minimize fuel consumption; whereas Green Logistics implies “an environmentally friendly and efficient transport distribution system”[3]. In the last ten years, several major companies have restructured their storage and distribution systems with a view to reducing their costs, and have subsequently reduced their CO_2 emissions because of those changes. However, not all infrastructure changes lead to a positive impact on the environment. The objective of the paper is to critically examine in particularly we are interested in the models that consider both economic (gold) and environmental (green) criteria simultaneously as their objectives.

2. Green Logistics

The supply chain transforms inputs into goods and services. Supply chain inputs include human labor, raw materials, and (renewable and non-renewable) fuel sources. The supply chain of the future will emphasize renewable fuel sources, as non-renewable sources become more scarce and expensive[7]. As the price of fuel continues to increase, firms are engaging in collaborative methods to reduce transportation costs. The global warming is getting worst as long as the energy demands are met by the fossil fuels. This is a fact that a supply chain network consists of industrial/distribution processes and needs transportation fuels to actualize these processes [1].

The rapid and continuous growth of vehicle population has also brought great challenges to global energy resource security especially on fossil fuels. The large transportation system in the world is based on gasoline and diesel fuels, which would dramatically increase the world dependence on oil imports. With globalization, automobile companies have to compete with their international counterparts. As a result, the Chinese automobile supplies have struggled to improve their economic and environmental performance simultaneously. Today the need for ‘desirable’ environmentally friendly networks is becoming ever more urgent. Beamon [7] outlines a range of sustainable performance measures, such as emissions, total energy consumed and others for green supply chains.

3. Green Logistics Modeling in Automobile Alternators

Collecting and transporting of used product is main task of RL. It can take place through the original forward channel, through a separate reverse channel, or through combinations of the forward and the reverse channel. The first quantitative model for closed-loop network in supply chain was developed by Fleischmann et al. that they tried to optimize forward distribution and recovery used product flow simultaneously [8]. Then, many scholars have studied to optimize the RL network for several different industries. Our objective is develop a new model to collection and recycling automobile alternators in end of life and minimize fossil fuels that should be consume for transporting. Regarding to bill of material for producing alternators, aluminum price is a major cost component. Then, they would like to recycle the aluminum from used alternators and thereby used as a raw material for new alternator production instead of purchasing original aluminum material from the suppliers. In case of recycling alternators, there is forward and reverse logistics networks that can be designed as a closed-loop network. In forward supply chain, the major raw materials such as aluminum and copper wire are prepared from different suppliers for automobile alternator producing. The alternators are produced by different manufacturing plant. It has to be distributed through distributors, wholesalers, retailers and finally deliver to consumers. Fig. 1 demonstrates a closed-loop supply chain for recycling alternators. For having a optimize logistics networks and avoiding to exceed transportation, a test function proposed by authors.

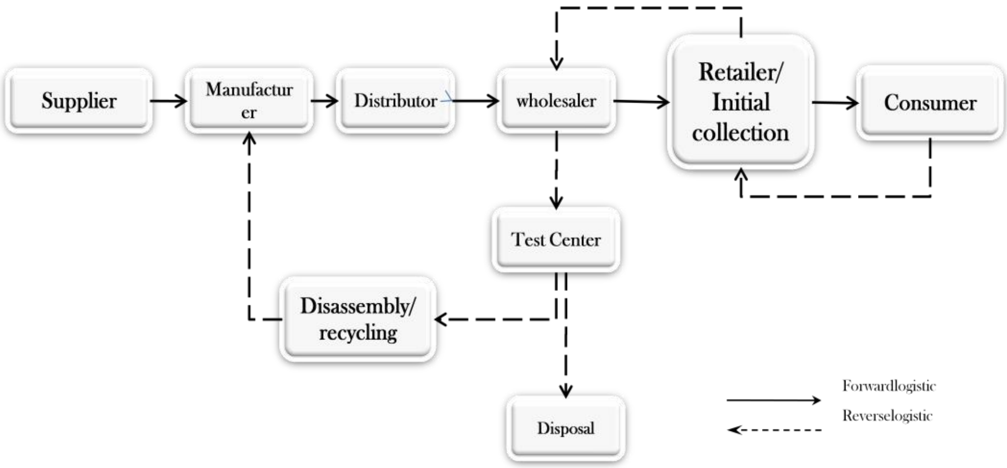

Fig. 1: Proposed model for reverse logistic for automobile alternator recovering

After end of life cycle, the automobile owners always leave the used alternator at the automobile service station that normally it can be mentioned same point with retailers. So, reverse logistic retailers collect used alternators and play as a collection point. The used alternator collected at the retailers should be quickly transferred to test section instead of transferring to disassembly and recycling point directly. In this point, alternators should be check that they are recyclable or should be sent to disposal. It can be avoid useless transportation and save fuels. In disassembly section, used alternators disintegrate to the main part and then aluminum extract from used materials and useless alternators should be disposed. After cleaning and purifying extracted aluminum, it can be reused in manufacturing site as row material again along with original materials for producing new alternators.

4. Over View of Genetic Algorithm

At the first time Holland introduced Genetic Algorithm in 1975 [9]. The Genetic Algorithm has been applied to various types of problems such as solving hard problems, machine learning, and optimization. Genetic Algorithm is a stochastic search techniques based on the process of natural selection and genetics referring to the Darwin theory. Genetic Algorithm is distinctive from conventional optimization techniques in the way that it is initialized by a set of random generated solutions called population. A chromosome, in the final stage, will give out solutions to the objective function, which is called fitness function in Genetic Algorithm. The chromosome is a string of variables that is usually, but not necessary, a binary string. The chromosome evolves through successive iterations, which are named generations. During each generation, fitness function evaluate the chromosomes. Some of the fittest chromosomes are selected to generate the next generation or offspring via recombination process. Some of parents and offspring that have highest fitness create a new generation. Fitter chromosomes have higher probability to be selected. After amount of generations, the algorithm converges and the chromosomes that have higher fitness value are obtained. These chromosomes in a final population represent the solutions to the objective function at hand [10].

5. Result

In this section, the Genetic Algorithm is used to minimize mix integer linear for model fuel consumption in network that we have developed regarding to concept model. The total fossil fuel consumption in the reveres logistic considered for comparing fuel consumption before and after test function in our model. Based on the case of recycling alternators data, we used Matlab software and set genetic algorithm parameters (population size is set to 50 and the maximum number of iterations is set to 200). Fig. 2 has comparison fuel consumption before and after test function including in reverse logistics.

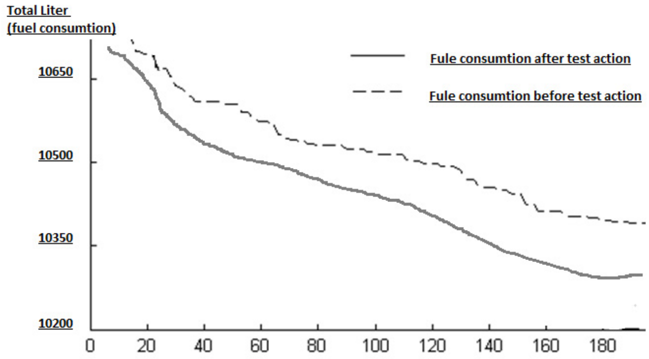

Fig. 2:Test function affect on fuel consumption in reverse logistics.

6. Conclusion

We tried to review briefly on green logistics literature and then proposed a new model for collecting and recycling automobile alternator in their end of life. As result revealed, adding a test function after collection centre and avoid exceed transporting by checking and distinguish recyclable parts. It can minimize fuel consumption rather general models. Besides fossil fuel that can be the corresponding of environment, establishing and running cost for test function should be consider in model in future work.

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