

## Optimizing Sustainable Pharmaceutical Distribution Network Model with Evolutionary Multi-objective Algorithms (Case Study: Darupakhsh Company)

**Nassibeh Janatyan**

Ph.D. student, Department of Industrial Management, Management and Accounting Faculty, Shahid Beheshti University, G.C., Tehran, Iran, n.janatyan@yahoo.com

**Mostafa Zandieh\***

Associate Professor, Department of Industrial Management, Management and Accounting Faculty, Shahid Beheshti University, G.C., Tehran, Iran, m\_zandieh@sbu.ac.ir

**Akbar Alem Tabriz**

Professor, Department of Industrial Management, Management and Accounting Faculty, Shahid Beheshti University, G.C., Tehran, Iran, a-tabriz@sbu.ac.ir

**Masood Rabieh**

Assistant professor, Department of Industrial Management, Management and Accounting Faculty, Shahid Beheshti University, G.C., Tehran, Iran, masood.rabieh@gmail.com

**Abstract:** Pharmaceutical Industry in Iran has difficulties such as inappropriate distribution, expired drugs and late drug delivery to patients. To overcome these issues and reach a sustainable development, the environmental and social aspects must be considered beside the economic aspects. In this paper, we address the Pharmaceutical distribution network and design a novel model that helps the distributing companies to decide strategic (determining the main and local distribution centers) and tactical decision (determining the flow) according to the three aspects of sustainability. The solution through the evolutionary algorithms presents the best selection of local distribution centers and the optimum amount of flow of medicine through the network with respect to three aspects of sustainability.

**Keywords:** Pharmaceutical Distribution Network, Sustainability, Multi-Objective Model, Evolutionary Algorithms, Taguchi Design

**Introduction:** In order to compete in the universal market, pharmaceutical companies must amend their competency. This coemption market needs to select the certain level of commitment for sustainability aspects to reach the sustainable supply chains. For this purpose, this study considers three aspects of sustainability (i.e. economical, environmental, and social pillars) to design the pharmaceutical distribution network. So, the model has three objective functions. The first function is to minimize the cost of transportation through the network, the second is to minimize the CO<sub>2</sub> emissions through the network and the third is to maximize the job creation through the network.

Carter and Rogers (2008) used the concept of ‘true sustainability’. They suggested that the consideration of environmental and social issues should be “coupled with economic objectives” and assist the company’s strategic long-term planning. Mota et al. (2014) considered this research question: “How can sustainability be integrated in to supply chains’ design and planning decisions?” Several methods and frameworks have been proposed to evaluate environmental effects.

**Materials and Methods:** This model is a multi-objective mixed integer linear programming (MILP) and is NP-hard. We have used the evolutionary algorithms (NSGA-II, MOPSO) to solve the problem and achieve the Pareto frontier. The Taguchi design experimental design has been used in order to tune the parameters of the algorithm. For comparing two evolutionary algorithms’ performance indicators of spacing (S), mean ideal distance (MID), Time and number of solutions (NOS) have been calculated.

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\* Corresponding author

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**Results and Discussion:** As a real case study, the proposed model is used in Darupakhsh. This company is one of the biggest pharmaceutical companies in Iran. The model has been customized with Darupakhsh's features for selected medicine. This company has a main distribution center and twenty local distribution centers. Twenty important customers have been assumed in this research. Solving the model with the evolutionary algorithms of NSGA-II and MOPSO and comparing to traditional method of weighted sum, highlighted the superior of MOPSO in economical and environmental aspects. The weighted sum method had a better answer in the social aspect. Overall, the power of evolutionary algorithms have been proved because of the Pareto frontier present to the researcher.

**Conclusion:** This research focused on designing the sustainable pharmaceutical distribution network. The proposed model is a multi-objective mixed integer linear programming (MILP). This model was tested in Darupakhsh Company. In this case, MOPSO had better performance than NSGA-II. The solution presents the best selection of local distribution centers and the optimum amount of flow of medicine through the network with respect to three aspects of sustainability. For further research, studying the uncertain parameters in this model and a suitable approach to deal with uncertainty could be proposed.

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