Demand and supply planning for Covid-19 vaccine in Turkey with an anti-vaccine survey

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Abstract

The Covid-19 virus, which affects many people, continues in a very contagious state. Vaccination is necessary to end this pandemic period, which everyone wants to end as soon as possible. The studies in the literature focuses on different phases of the vaccination such as product, production, allocation or distribution. Existing, expected and sudden outbreaks are studied considering developed and developing countries. But many studies in the OR/OM community focus on expected outbreaks in developed countries. There are however a limited number of studies for sudden outbreaks because of the uncertainties. Therefore, in this study, we focus on Covid-19 which is a sudden outbreak and the study is executed in a developing country, Turkey. As the attitude towards vaccination might differ across subpopulations, vaccine hesitancy might affect all of purchasing, distribution, and allocation decisions of vaccines. We conduct a survey in order to reduce the uncertainties about the vaccine demand. We analyze on vaccine selections, government decisions about the purchase of the vaccines, vaccination groups and create a supply chain plan considering that the vaccines are available in batches over time. Covid-19 affects us in a very harmful way and there are several issues we can consider in order to come up with an efficient vaccination plan. Since the vaccine demand is the key factor that effects our decisions, we have to forecast the demand with the least error we can get. If the predicted demand is higher, we would purchase vaccines more than we need and we have to deal with wastage and purchasing costs. If the predicted demand is less than the actual demand, we would miss the opportunity to vaccinate more people and to get closer to the end of the pandemic. So, by predicting the demand in an accurate way, we can make more meaningful decisions in our supply chain. In our survey, we predict the behavior of individuals in Turkey by asking questions about side effects of vaccines, the acceptance of vaccine brands, the distrust of the government and the number of cases announced, etc. The responses help us plan the supply chain weekly, considering most of the thoughts of the community. After forecasting the weekly demand for each vaccine brands, we use them in our optimization model to construct a weekly vaccine supply plan for each vaccine brand for Turkey over a one-year planning horizon. The goal of the optimization model is to minimize the total costs of purchasing, transportation, storage, and backordering costs. In this model, we consider storage and transportation capacity limits, minimum required vaccination rate to reach the herd immunity, and vaccine demand satisfaction with respect to priorities of different risk groups.

Keywords
Demand forecasting, Vaccine supply chain planning, Optimization, Covid-19 vaccine, Vaccine Hesitancy

Biographies

İrina Pınar Tuğrul is an MSc student of Industrial Engineering in Ozyegin University. She received her BSc in Industrial Engineering from Istanbul Sehir University in 2019. Her main aim in this research was to forecast the demand of Covid-19 vaccine and create a weekly supply chain plan accordingly.

Dr. Zehra Melis Teksan received her B.Sc. and M.Sc. degrees in the Department of Industrial Engineering at Bogazici University, in 2009 and 2011, respectively, and she received her Ph.D. degree in the Industrial and Systems Engineering department at the University of Florida in 2016. Besides her academic studies during Master's and Ph.D. years, she worked in several industry projects consisting of applications in production and logistics planning and scheduling. In those projects, she contributed as consultant, project manager, and R&D software product developer. Her main research focus lies in the field of production planning and inventory theory, and, in general, she is interested in research problems that are relevant to real-life industry practice.