ABSTRACT

The smart transportation of farming must carry food from agriculture, livestock, and fisheries from one location to another using diverse types of transportation modes to improve the wellbeing of citizens. The mathematical optimization model proposed in this chapter represents the problem of transportation of perishable products which aims to minimize costs and optimize transportation times and costs. Reduction of the time of transportation of perishable products increases the likelihood of delivering fresh products and minimizes economic losses. Transportation time and temperature suitable for the conservation of the product are priorities in this type of problem because the product is transported in time reduces the probability that the product will be exposed to extreme conditions that favor its decomposition. To check the feasibility of the model, this study proposes a set of instances subject to an application obtained a series of solutions that are analyzed to identify if there is a feasible solution.
Perishing Goods Transportation Problem

INTRODUCTION

Smart Farming and Smart Transportation are two important components of a Smart City to provide food for a city. The Smart Production of Foods or Smart Farming is the production of food from agriculture, livestock and fisheries with technology to optimize or monitor (in real-time by the Internet of Things Technology and other technologies) water, energy and food. The Smart Transportation must be optimized (minimize the cost of construction for the government and the cost to the citizens and maximize the utilization of the vehicles) and carry resources, goods or people from one location to another location using diverse types of transportation modes (ship, aircraft, truck, train, pipeline, motorcycle and others) by air, water, road, aerospace, tube and cable, with the objective to improve the well-being of citizens.

Products that have a temperature-dependent life and shelf life are known as perishable. A perishable product loses its nutritional value or active substance when the storage time exceeds the expiry date of the product. External agents (biological, chemical or physical) deteriorate the organoleptic properties (taste, aroma, colour, appearance or texture) of such products, regarding their composition or their nutritive value. The perishable goods include foodstuffs, medicines, vaccines, and chemicals among others. Food such as meats, vegetables, fruits, dairy products, and egg must be transported at a temperature of below 5 °C. Vaccines and medications between 3 to 5 °C. Chemical substances, such as concrete (which is a substance considered not storable perishable product), must be transported in conditions between 1 to 3° C. A perishable product is affected by microorganisms which are necessary conditions because they feed on nutrients, look for a humid environment and a comfortable temperature for playback. Microorganisms can be damaging and pathogens. A deteriorating microorganism does not cause disease, but it erodes the color, texture, flavor, and aroma of food. A pathogenic microorganism causes disease and does not change the physical appearance of the food. Pathogenic microorganisms that commonly attack this type of food are bacteria, fungi, parasites, and viruses. It is important to take care of the time and temperature to conserve a perishable product from not losing their nutrition or active value. This type of product-producing companies must take into account factors of conservation to guarantee the nutritional quality of the product to the final consumer. An external factor that may affect the conservation of a product is that they are not suitable for shipping temperature. The most common economic loss is generated by bad transportation of the product, the poor condition of transportation units and bad programming of the distribution routes. Units of transportation of such products are classified in isothermal vehicles, refrigerant vehicles, refrigerated vehicles and heating vehicle units that should be equipped with a cooling system and optimum performance.

To the date, there could not be found a mathematical model that represents the problem of transportation of perishable goods. This problem is considered a variant of the Vehicle Routing Problem. This chapter intends to represent mathematically the problem of the transport of perishable goods taking into account variables that could affect its nutritional value and optimize the cost of transportation involved in moving the product from one place to another. This chapter is organized in different sections, which are the Related Works section, the Mathematical Model section, the section of Experimentation, which describes the instances used, and finally the Conclusion section.
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