


Optimized Options for Fresh Food Deliveries in Baltimore Food Deserts

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ABSTRACT

A food desert is an area with limited access to healthy and affordable food. This study evaluates various alternatives of a last-mile fresh food delivery system to address issues of limited access to fresh food sources for individuals living in so-called food deserts. Six different combinations of five transportation modes—truck, e-bike, shared-ride, pop-up truck, and third-party delivery car—and a locker facility system are evaluated to determine the total delivery cost to serve a food desert area. The characteristics of each transportation mode are presented, and the total costs of delivery, including user costs, are computed for a case study area in Baltimore. The Network Analyst extension in ArcGIS 10.6 is used to estimate travel time, distance, and costs. The results show that delivery by a third party is the most cost-effective, followed by trucks and e-bikes. The shared-vehicle and pickup bus alternatives are the most expensive. On the other hand, deliveries made by pop-up trucks have the lowest operating cost.

KEYWORDS

Baltimore, Cost Estimation, Different Mode of Transportation, Food Delivery, Food Desert, Fresh Food Delivery, Geographic Information System, Network Analyst

INTRODUCTION

A food desert is a ubiquitous term among professionals in the transportation and public health sectors. The phrase ‘Food desert’ was first used in Scotland in the early 1990s (Walker, Keane, & Burke, 2010). Recently, issues related to food deserts, primarily inner-city areas, have been of concern to U.S. public agencies at various levels. The Food and Nutrition Services (FNS) of the U.S. Department of Agriculture (USDA) defines a food desert as “a low-income census tract where more than 20% of

DOI: 10.4018/IJUPSC.301555

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residents earn income at or below the federal poverty levels for family size, or at or below 80% of the surrounding area's median family income and where at least 500 persons or 33% of their population do not have a supermarket or large grocery store within one mile of their residence in urban areas or 10 miles in rural areas" ("Food Access Research Atlas," 2017). In this definition, two essential phrases are the thresholds that classify areas as 'low-income area' and 'low access.' Some variations—e.g., threshold values and alternative phrases for food deserts—based on the FNS' definition have been coined by local governments to reflect their socioeconomic conditions. For example, in 2018, the City of Baltimore changed the term 'food desert' to 'Healthy Food Priority area' (Misiaszek, Buzogany, & Freishtat, 2018).

The food desert is identified as one of the primary contributors to unhealthy eating by public health researchers (Bitler & Haider, 2011) (Hilmers, Hilmers, & Dave, 2012). In some areas, people can access fast food within a few blocks but have no grocery stores within a reasonable distance, say, about a mile. While public transit or driving are obvious travel options to fresh food sources, the reliability of and access to public transit and low vehicle ownership have been identified as the most critical barriers. Walking can be another alternative, but many elderly or disabled persons cannot travel to grocery stores on foot. To address their limited mobility issues, delivering fresh food to their doorstep would be a desirable alternative. There are number of food delivery systems available all over the world for restaurants. People can order their food and get it delivered. However, for fresh food, the number of the delivery systems is significantly less than restaurant delivery systems. Amazon Fresh is one of the options one can subscribe to with a monthly or yearly payment that delivers in some urban areas. Amazon delivers fresh items the same day or to the next day. However, this is not available for all urban areas. Instacart partners with many major grocery stores such as Giant Food, Wegmans, Shoprite and Safeway and it is also getting popular for food delivery.

With that said, this study, using the Baltimore food deserts as a study area, developed a last-mile fresh-food delivery system for individuals in underserved communities and compared options to identify the most cost-effective alternative. The combinations of six delivery modes and a locker facility option were evaluated. The characteristics of each mode and travel system were presented, and the total cost of delivery was computed mathematically with the cost equations developed in the previous research. The study optimizes the individual modes separately and compares the results.

BACKGROUND

Most food desert studies have focused on the emergence of food deserts, the locations of fresh food sources (e.g., larger grocery stores) individuals' accessibility and mobility, related health issues, and socioeconomic attributes of the area residents (Beaulac, Kristjansson, & Cummins, 2009; D. A. Freedman & Bell, 2009; Gordon et al., 2011; Moore, Diez Roux, Nettleton, & Jacobs Jr, 2008). Several studies have addressed the impact of the development and closure of food stores on fresh food access (Guy, Clarke, & Eyre, 2004). The availability of grocery stores within a reachable distance is also a significant concern. Indeed, smaller neighborhood supermarkets are becoming extinct due to competition from supermarket chains (Furey, Strugnell, & McIlveen, 2001). While location decisions of grocery stores are based on a profit-maximizing market principle, from the perspective of fresh food availability, the limited access to fresh food sources is an example of market failure that justifies public sector involvement, because underserved individuals tend to be beleaguered and stuck in poverty-prone inner-city areas. The opening of one new big food chain on the outskirts of inner cities offers consumers quality food and a variety of options. These places also have ample parking and longer operating hours. However, the expansion of the larger stores is geared more toward people who have their own transportation modes (Guy et al., 2004). These larger supermarkets drive out the smaller traditional neighborhood stores, thus depriving people without any means of transportation of access to fresh food (Alwitt & Donley, 1997; Guy et al., 2004). One study shows that low-income neighborhoods had 52% fewer supermarkets while high-income neighborhood

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