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Alleviating food disparities with mobile retailers: Dissecting the problem from an OR perspective

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ABSTRACT

Within the past 20 years, disparities in access to healthy and affordable foods have been observed within urban communities leading to significant negative health and diet related repercussions. One recent technique to alleviate such conditions is to introduce a mobile food retailer within the community but preliminary evidence raises concerns regarding this retail format. While extensive literature exists regarding other alleviation strategies, research on mobile food retailers has been sparse. To facilitate new research into the efficacy and deployment of mobile food retailers, operations research tools are outlined and discussed. These tools specifically address the product mix and the routing plan of the retailer as these decisions represent the greatest barriers to success for current retailers. A set of potential tools is developed and employed within a preliminary case study in a Phoenix, Arizona community and the results demonstrate the utility of the methodology by identifying changes to both the product mix and routing plan which could result in greater earnings potential.

1. Introduction

One of the more recent social inequalities identified within the US is the existence of urban communities which lack easy and affordable access to healthy foods. Such communities are now commonly referred to as 'food deserts' and have been defined by the United States Department of Agriculture (USDA) in the 2008 farm bill as an "area in the United States with limited access to affordable and nutritious food, particularly such an area composed of predominantly lower income neighborhoods and communities" (Food, Conservation, and Energy Act of 2008, 2008). To accompany this definition, the USDA developed threshold criteria to establish if an urban census tract should be classified as a food desert. The initial criteria developed by the USDA identified an urban food desert as any tract where at least 500 people or 33% of the residents live more than a mile from the nearest supermarket *and* the census tract's poverty rate is greater than 20% or meets similar poverty requirements. Currently using these definitions, 13.6% of all urban US census tracts are classified as food deserts. In total, this encompasses 33 million residents. Since these initial definitions, the USDA has added varying criteria on distance and poverty, but even the most conservative definitions indicate that 19 million people reside in the 7.7% of urban census tracts that are categorized as food deserts.

To address this issue, numerous alleviation strategies have been proposed. One of the most popular approaches is to introduce a new, traditional food retailer into the community such as a supermarket or grocery store. However, it has been identified that some of these communities do not have the requisite purchasing power to support such a retailer (Califano, Gross, Loethen, Haag, & Goldstein, 2012). In these instances, common alleviation strategies include improving existing small retailers, promoting community developed initiatives, and improving the existing urban infrastructure (Rose et al., 2009).

While these traditional remedies have shown some success in certain communities, a novel vehicle-based retail format has emerged which is specifically designed to alleviate urban food desert conditions. This mobile retailer is typically a large vehicle (e.g. a repurposed bus or a large trailer pulled by a truck) which is stocked with healthy food items that are sold within food desert communities at specific locations according to a predetermined schedule. Even though this retail format for healthy foods did not exist 15 years ago, examples of these retailers can currently be found in over a dozen US cities.

In spite of the growing popularity of this retail format, mobile retailers have yet to demonstrate that they can be an effective alleviation technique since they have had minimal success at

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becoming economically sustainable. Most, if not all, existing mobile retailers receive a significant portion of their funding from federal or local grants and even long serving mobile retailers experience difficulties in obtaining sufficient income to offset their operational costs. Such a strategy is clearly unsustainable for any permanent alleviation remedy.

This initial inability for mobile retailers to reach economic sustainability has created significant concerns regarding the efficacy and longevity of the mobile retail format in alleviating food desert conditions. To address these concerns, it is proposed that research be conducted into the necessary community conditions (i.e. population, purchasing power, population density, road network, etc.) and into the mobile retailer decision making process to understand the factors that impact the economic sustainability of mobile retailers. To date, there is no research specifically addressing the community conditions and only limited research exists on the decision making process but none has specifically focused on *all* of the nuances of the mobile retailer.

Given this gap in research, the purpose of this article is to outline the proposed analysis methodologies to investigate the true economic feasibility criteria for mobile retailers. Specifically, the motivation for using operations research (OR) modeling techniques, which have rarely been applied to the food desert problem, will be presented and possible research methodologies will be suggested and outlined. The utility of these methods will then be demonstrated through a preliminary case study. This discussion and study will serve as a starting benchmark on possible OR techniques for current researchers who are seeking to address food deserts or similar issues.

To accomplish this goal, the scale and effect of the food desert problem will be summarized to motivate the need for research into alleviating food deserts with mobile retailers. Following this summary, key decision points for the mobile retailer will be determined and possible OR techniques will be identified which can assist researchers in understanding the feasibility of employing mobile retailers within food deserts. The advantage of this approach is that a carefully developed tool can be employed by researchers to study the ramifications of mobile retailer decisions as well as by mobile retailer coordinators who seek decision support assistance in their operational decisions. An initial case study will then be presented using operational data from the Phoenix metropolitan area.

2. Food desert background and alleviation

To motivate the need for research into alleviating food deserts, the extent and effect of food deserts must be documented. Hence, a summary of the most recent statistical research into access disparities and the effect these disparities have on community and individual health will be provided. This will ultimately demonstrate alleviating food deserts is a justifiable use of time and economic resources within underserved communities. Common approaches to alleviating food deserts will then be presented. These approaches will conclude with a discussion regarding the advantages and disadvantages of the mobile healthy food retailer.

2.1. Extent and effect of food deserts

Considerable effort has been expended to determine the extent of food desert communities by researchers across numerous disciplines and organizations. Since summarizing all of this research is outside of the scope of this discussion, the following section presents the most recent research into statistically significant disparities in food access. For readers interested in more food desert research, summaries of existing literature are provided by Caspi, Sorensen, Subramanian, and Kawachi (2012), Walker, Keane, and Burke (2010), McKinnon, Reedy, Morrissette, Lytle, and Yaroch (2009), and Beaulac, Kristjansson, and Cummins (2009).

The key issue with current research into the existence of food deserts is that there is little consistency when defining the community, healthy food, and access criteria required for an area to be classified as a food desert. For instance, Ver Ploeg et al. (2009), the study accompanying the USDA's definition of a food desert, used 1 km. grids as proxies for communities while defining poor access to healthy foods as living more than a half mile (or full mile) away from the nearest supermarket with additional requirements including the resident being low-income and possibly not having access to personal transportation. In comparison, Rose et al. (2009) used census tracts to define a community and measured disparity based on access to all food retailer types within a 1 (or 2) km. radius while considering the actual shelf space dedicated to fruits and vegetables in these stores. While it is not the focus of this discussion, this important shortcoming is mentioned because these differences in parameters are pervasive throughout food desert literature and hinder a concise conclusion on the existence and extent of food deserts. Readers interested in a thorough discussion of this and other issues within food desert literature are recommended to read Bitler and Haider (2011).

With this shortcoming in mind, existing food desert studies are still useful in identifying *local* statistical disparities in access. For instance, numerous studies into the existence of food deserts indicate that at-risk demographic groups have statistically less access to supermarkets then their reference groups. This applies to low-income versus high-income (Baker, Schootman, Barnidge, & Kelly, 2006; Block & Kouba, 2007; Larsen & Gilliland, 2008), Black versus non-Hispanic White (Bader, Purciel, Yousefzadeh, & Neckerman, 2010; Baker et al., 2006; Powell, Slater, Mirtcheva, Bao, & Chaloupka, 2007), and Hispanic versus non-Hispanic White (Bader et al., 2010; Moore & Diez Roux, 2006). However, the opposite is true for access to smaller or independent food retailers since it appears that most at-risk groups have better access to these types of stores (Moore & Diez Roux, 2006; Morland, Wing, Diez Roux, & Poole, 2002; Powell, Slater et al., 2007). For the purposes of this summary, smaller stores include independent grocery stores, fruit and vegetable markets, meat markets, farmers' markets, or similar independent food retailers.

These results demonstrate that even if urban, at-risk groups may be underserved by traditional retailers, smaller retailers could fill this gap. For instance, when the proportion of Mexican–Americans started to increase in the southwest US, small ethnic grocery stores called *Carnicerias* naturally arose as a method to address the need for community-specific foods (Duran, 2007). Hence, it appears that natural economic development favors smaller food retailers within the urban food desert environment. Such a result is not surprising, but it is often overlooked by community developers seeking to alleviate food desert conditions.

Given these disparities, significant research has been undertaken to quantify the potential effects of having poor access to healthy foods. With respect to supermarket access, numerous studies have investigated if having poor access to supermarkets implies that at-risk communities pay more for their healthy food purchases. These studies have unanimously found that low-income citizens do not spend more on food items. In many instances, low-income urban populations have statistically less food expenditures than high-income shoppers even though studies have demonstrated that the stores more frequently located nearby low-income populations tend to have higher food prices (Andreyeva, Blumenthal, Schwartz, Long, & Brownell, 2008; Kaufman, MacDonald, Lutz, & Smallwood, 1997).

One theory for this phenomenon is that lower-income shoppers are more likely to rely on lower quality food items as measured by the look and freshness of the food. In support of this theory, Block