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Evaluation of dine-in restaurant location and competitiveness: Applications of gravity modeling in Jefferson County, Kentucky

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ABSTRACT

The selection of a quality site in a competitive market is critical to the future success of a dine-in restaurant. This paper focuses on the development and application of different forms of gravity models in the evaluation of a restaurant's location and competitiveness in Jefferson County, Kentucky. It also assessed the effectiveness of these applications empirically. Three models are presented, a market potential model, a complex gravity model, and a competing destinations or Huff model. The models incorporated into them the most significant variables affecting interaction with customers at restaurants. A correlation analysis was conducted on a sample of restaurants along a popular segment of local eateries in Jefferson County to determine if any statistically significant linear relationships exist between market potential or spatial interaction and real customer volume and longevity at the restaurant.

Within a highly localized market area where restaurants are within close proximity and contain similar markets, a market potential model was unable to accurately capture the real conditions of this market. The gravity model was able to accurately reflect these conditions, but as the variables within the model were manipulated the strength of the correlation decreased and the model became less accurate. The highly localized study area indicated the importance of the site characteristics in attracting customers, as well as the importance of the appropriate selection of variables in modeling to reflect an accurate magnitude of spatial interaction.

Introduction

The location of a restaurant is vital to its long-term success, especially since over a quarter of restaurants fail within their first year of operation (Parsa, Self, Njite, & King, 2005). Achieving future success starts with a restaurateur first identifying a general area for business, followed by the selection of a specific property within that area (James, Walker, & Etzel, 1975; Park, 2002; Powers, 1997). Site location has been increasingly recognized as the single most important element in determining its profitability and overall success (Ghosh and McLafferty, 1982).

While in the past site selection may have been based on intuition, a wide spectrum of techniques is used for site selection and potential and current market study (Alghanb & Lee, 2011; Joseph, 2009, 2010; Rogers, 1987; Roig-Tierno, Baviera-Puig, Buitrago-Vera, & Mas-Verdu, 2013). This may include data analysis, sales forecasting, general area analysis of economic and demographic conditions, potential competition and growth, or simply checklists (James et al., 1975; Park, 2002; Prewitt, 2007; Talaga, 2010; White, 2008). One of the most effective and comprehensive techniques used by geographers for site evaluate is gravity modeling.

Gravity models have proven effective in explaining commuting flows, journey to shop, social trips, commodity freight exchange, and migration patterns (Kaplan, Wheeler, and Holloway, 2009). While Pearson (2007) noted that the classic gravity model does not consider demographic factors, an integral requirement for any restaurant market assessment, it has proven flexible in accommodating different measurements of size or attractiveness (such as floor space, retail sales, or employment), and distance can be manipulated into a multitude of impedances, for instance, travel time or cost (Bradford and Kent, 1978; Kaplan et al., 2009). The flexibility of the classic model allowed it to take a more generic format giving way to multiple applications of location based problem solving. In Pearson's (2007) research a market potential model was used to evaluate the best location for a new Kowalski's

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Market in the Twin Cities metropolitan area. Yamashita (1995) explored the use of a competing destinations model, also known as the Huff or consumer choice model, to solve the problem of service facility location. Thurman and Song (2005) used a manipulation of this same model to determine the optimal location of a Regional Market Center in a low-income area of west Louisville, Kentucky. Refined gravity models have been constructed to be more realistic (Wan, Zhan, Zou, & Chow, 2012).

While gravity modeling is an integral tool for evaluating spatial interaction, Bucklin (1971) suggested that there is always a probability that a consumer's preference may be for hypothetical location *K*, as opposed to center *M*, even if location *K* is not as attractive or at a greater distance. If this were not the case, there would be impenetrable barriers to less attractive or more distant geographical destinations. Since it would also be impossible to include all variables that affect location choice, a well-specified model should include the most influential variables impacting a consumer's site selection and ability of the site to attract and generate customers from the market.

Thus, the objective of this research is to develop an effective method for site selection using applications of gravity modeling on a representative sample of restaurants within Jefferson County, Kentucky. This objective includes two parts. The first focuses on the development of different forms of gravity models to evaluate a restaurant's location and competitiveness in a local market. The second strives to assess the effectiveness of these applications empirically. To provide empirical evidence, the relationship between modeling application outputs and two variables at each restaurant in the sample (lifespan or number of years in operation and weekly customer volume) are analyzed, hypothesizing that as the modeling output magnitude increases, lifespan and weekly customer volume would be greater.

Study area, methods, and data

Thirty dine-in restaurants in Jefferson County, Kentucky, surrounding an eclectic segment of Bardstown Road (from Eastern Parkway to Taylorsville Road), were selected to represent the sample for model development. The study area consists of a collection of thirty-six Census (2010) block-groups within one mile of the sampled segment of Bardstown Road. A one mile market radius reflects the artificial barriers at the southwestern and northeastern edges of the area which severely limit accessibility, as well as recommendations by Talaga (2010) for evaluating a highly localized market where the geography is specific to the location. These barriers include Calvary Cemetery and Joe Creason Park on the southwestern side, and Interstate-64 and Cherokee and Seneca Parks along the northeastern border. 37,750 people make up this market, of which 21,150 are employed, and median household incomes range from $31,985 to $90,000 (United States Census Bureau, 2010a, 2010b). The geographic configuration of the sample and study area is presented in Fig. 1.

Each restaurant's potential market area is localized to a unique population base, block-groups within one mile of the site. This localization of market areas eliminates irregularities in distance between the site and its surrounding population base by removing any unfair advantage a restaurant may gain by being centrally located within the study area. This is essential for developing accurate models specific to a unique site.

The site evaluation method is formed by transitioning through three gravity model formations that introduce relevant variables impacting spatial interaction between the site and customers. The methods include a market potential model, a complex gravity model, and a competing destinations model. Testing the validity of modeling effectiveness was achieved through a correlation analysis using Statistical Package for the Social Sciences (SPSS) with scatter-plots and trend-lines as a visual supplement. Validation will be indicated by a strong, positive, and statistically significant linear correlation between modeling outputs and lifespan or customer volume.

The site evaluation method began with a market potential model adapted from Reilly's law of retail gravitation stating that a place attracts trade from its surrounding area in direct proportion to the population and in inverse proportion to the distance (Hannick, 1997). Similar to Pearson (2007), the model for this research also included a measure of income:

$$MP_j = \sum_i \frac{H_i P_i}{D_{ij}} \tag{1}$$

where MP_j is the market potential of restaurant j, H_i and P_i are the median household income and population of census block group i which is within one mile of the restaurant site, and D_{ij} is the distance between restaurant j and block-group i. The incorporation of median household income was based on research concluding that higher household income groups are more likely to spend money away from home on food and be frequent diners, while increased distance and low income help explain low market potential (Parsa et al., 2005; Pearson, 2007; UBS Securities, LLC, 2003).

The market potential model only considers the one-way attraction of the localized market to the site or its ability to generate interaction. To account for these limitations a complex gravity model was developed to incorporate unique characteristics of the site's attractiveness and qualities that generate customers and those which impede. The model becomes the foundation for site evaluation:

$$I_{ij} = \frac{H_i P_i S_j V_j A_j T_j}{D_{ij} M_j U_i} \tag{2}$$

where I_{ij} is the spatial interaction between the origin, block-group i, and the destination, restaurant j, H_i, P_i, and D_{ij} remain the same from Equation (1), S_j is the seating capacity of the restaurant, V_j is the visibility, A_j is the availability of parking, and T_j is a variable for traffic volume. These variables are acted upon by adding impedance M_j which is the restaurant's average menu price and U_i is the level of unemployment of block-group i. The impact on interaction caused by the placement of variables was tested by removing them one by one and in combination with each other, thus manipulating the gravity model, and comparing the results of each manipulation. A high quality site will be where the sum of spatial interaction is maximized. The numerical output of gravity modeling does not truly reflect the real number of estimated customers, but it reflects relative magnitude of that interaction.

The development of the gravity model, Equation (2), began by considering variables of customer attraction at the site. The seating capacity is necessary as it reflects a factor of size at the destination, and has an influence on interaction that varies directly with distance and is complementary to the size of the origin (Lukerman & Porter, 1960). Poor visibility has been linked directly to poor sales, and is calculated as the total amount of street frontage at the restaurant's property or the length of the building, in feet (Park, 2002). Additionally, a major concern is the availability of parking, calculated as the spaces which belong directly to the restaurant in the form of a parking lot, plus the street spaces directly in front of the building (CoStar Commercial Real Estate Information Company, 2012). Vehicular traffic also provides a certain level of exposure to a restaurant (City of Brillion, 2002). The variable used here represents the average daily volume of traffic at the closest traffic count point from a road along which the restaurant resides. Sites at a corner may contain up to two traffic counts.

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