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Assessing the community food environment: examining the impact of retail food availability and accessibility along travel routes for office workers in Polk County, Iowa

Joyce Gathoni Mbugua

Iowa State University

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Assessing the community food environment: examining the impact of retail food availability and accessibility along travel routes for office workers in Polk County, Iowa

by

Joyce Gathoni Mbugua

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
MASTER OF COMMUNITY AND REGIONAL PLANNING

Major: Community and Regional Planning

Program of Study Committee:
Francis Y. Owusu, Co-major Professor
Christopher J. Seeger, Co-major Professor
Tara L. Clapp

Iowa State University
Ames, Iowa
2010

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CHAPTER 1.

OVERVIEW

Introduction

*We ought to plan the ideal of our city with an eye to four considerations. The first, as being the most indispensible, is health.*
Aristotle, *Politics* (ca. 350 B.C)

As health issues increasingly become dominant in the national discussion, there is a dawning realization that the health and well being of our communities can be most effectively handled not only on an individual or household level, but also on a community or regional scale. Availability of health promoting resources such as amenities for healthy eating and physical activity, affordability of health care and awareness of preventive health measures have been recognized as central to maintaining healthy communities and encouraging healthy lifestyles (Glanz et al., 2009).

Research into the social and environmental determinants of health is an important addition to any investigation into the health and well being of a population. Social determinants of health and well-being include household socio-economic status, social support systems and individual perceptions about disease, while environmental determinants include the physical and built environments (Reidpath et al., 2002).
During the last two decades, the need for investigating the effects of the built environment on public health has gained prominence within the fields of Planning and Urban Studies. The way we think about the environment and its impact on health is steadily changing. Environmentally-oriented research has underscored the importance of the built and natural environments in influencing health behaviors and health outcomes (Stokols et al., 2003). Previously, environmental health focused primarily on the effects of chemical toxins and their influence on particular diseases such as cancers and respiratory illnesses. Today, environmental health encompasses not only the direct pathological effects of the disease triggers, but also the effects of the physical and social environments we live in. Components such as land use and urban development, housing, industry and agricultural practices are continually being investigated to determine their impact on individual and community health (Srinivasan et al., 2003). Recent studies have shown that certain environmental conditions seem to exacerbate the risk for disease and ill-health especially in the urban setting. For instance, studies have found correlations between cases of cancer and chemical toxins in neighborhoods built near or on former landfills (Srinivasan et al., 2003), and an increase in cases of childhood asthma caused by exposure to indoor and outdoor triggers due by poor housing standards and elevated ground ozone levels from traffic congestion (Brisbon et al., 2005).

Urban development patterns and land use policy have an immediate and prolonged effect on an individual’s lifestyle choices and changes. One of the greatest lifestyle changes in American society today was precipitated by the development of the interstate highway system and subsequent reliance on the personal auto. The construction of the highway system and development of major arterial roads has made using the personal auto the number one
choice for work and non-work related travel over public transit, walking or bicycling in many cities across the country (Transit Cooperative Research Program, 1997). Additionally, the suburbanization of the city has led to an increase in distances traveled both for work and non-work travel, creating more origins and destinations than can be efficiently and cost-effectively served by many public transit systems across the nation, which has in turn increased reliance on the personal auto even more (Transit Cooperative Research Program, 1997).

Highway commercial centers and nodes, currently designated as Highway Commercial Districts in many city zoning codes, develop alongside interstates and at interchanges as a response to the increased use of the highway system. These designations are intended for application to areas located near freeway interchanges, fronting on state highways or along arterials that provide access to major destinations. This corridor of outlets offering consumer and household goods such as convenience stores, grocery stores, fast food and full service restaurants, and rest stops are designed to accommodate all or most of the needs of recreation and business travelers with one stop.

Availability of and access to the food outlets located along these travel routes is an important component of one’s food environment. Neighborhood availability of food stores and access to healthy food options is an important factor in either enhancing or precluding healthy dietary behaviors for individuals and communities (Morland et al., 2006). Recent research has shown that residential neighborhoods with a paucity of nutritional offerings pose a higher risk factor for diet-related disease among residents. Neighborhoods with higher concentrations of the types of stores that typically offer high energy foods, such as fast-food outlets and convenience stores with fewer grocery stores and supermarkets, may increase
disparities in dietary intake (Morland et al., 2006; Glanz et al., 2007). Low-income, inner
city, multi-ethnic communities (Kipke et al., 2007; Morland et al., 2002) with higher
availability of food outlets that offer energy-dense foods (Cummins & MacIntyre, 2006;
Story et al., 2008) as well as those that have lower access to facilities that encourage physical
activity, such as parks and trails, tend to have higher incidences of overweight and obesity
(Frank et al., 2003). Since the food choices that people eat are limited to what is available to
them, and convenience is an important predictor for food habits, it is hypothesized that
individuals living or frequently commuting through areas with few food choices may be
more likely to adopt an unhealthy diet. Conversely, food environments offering a greater
variety of healthy food options at affordable prices may lead to healthier food choices
(Morland et al., 2006).

**Problem Statement**

There is a growing need to investigate how urban travelers interact with the food
environment along travel routes. Although there are studies that have been conducted
focusing on measuring spatial access to food (Morland et al., 2002; Maddock, 2004; Glanz et
al., 2005; Apparicio et al., 2007) and availability of healthy foods in the home and worksite
neighborhoods (Cummins & MacIntyre, 2002; Kipke et al., 2007; Zenk et al., 2005), there is
a paucity of literature on how food facilities along travel routes affect and influence dietary
decisions. As urban areas become less centralized and more spread-out, and as urban
dwellers have become more dependent on motorized transportation, distance to food outlets,
available food options, price and access to food outlets along travel routes become a major
determinant of the nutritional decisions commuters make.

This research will investigate how the food environment along travel routes between the home and work place affect the nutritional behavior of a sample of Polk County workers. For many out-of-home workers, the commute between work and home provides an important opportunity to purchase food. Access to the food choices available along these routes may determine individual dietary decisions, especially in the presence of restrictions such as travel mode, time and distance.

The objective of this study is two-fold: First, to examine the local food environment along workers’ travel routes and to develop an area-wide (instead of household or individual) perspective on how it influences commuting workers’ diet-related decisions. To do this, I focus on factors that determine spatial access to the food environment on two different levels. First, on the community level, features such as the number, type, location and density of food outlets and food service places are used to characterize the food environment. Next, on the individual level, attributes such as travel route, distance traveled between home residence and work site, as well as distance traveled to food stores or food service outlets are used to measure spatial accessibility of the food environment.

The second objective relates to the need for accurate and reliable measurement tools and techniques in food environment studies. Despite the increased interest in nutrition environments, little progress has been made in devising versatile, reliable and valid measures and instruments that can be applied to a number of different conditions. Some progress has however been made towards operationalizing spatial access to the food environment. For instance, measures have been developed to encompass the most important dimensions of accessibility such as measurement of \textit{proximity} (distance traveled to the nearest food outlet),


_**diversity**_ (type and number of food outlets within a certain specified distance) and _**density**_ (proportion or ratio of food stores per county, census track or block group or per population) (Sharkey, 2009). Studies that look at the nutritional value and economic issues in food access also include _food/price variety_ (average distance to the three closest different chain-name supermarkets) as an important parameter to be measured (Sharkey, 2009).

Although there are ongoing efforts to expand and develop these measures, most of it is focused on residential or work-site food environments. There is therefore still a dearth of methodological instruments and geographic accessibility measures that take into account the unique concerns that travel route food environments present. Applying readily accessible geographic analysis techniques, a new public participation methodology is developed and tested in this study. This methodology enables the collection of data that can be assessed and applied towards investigations on the food environment along highway and arterials and their influence on commuters’ food purchasing behavior.

The objectives are to:

- Develop _spatial_, or area, perspective to food access along workers daily work travel routes and,
- Develop and test a new web-based public participation methodology for spatial data collection.

The first objective is addressed by answering the following study questions:

i) How does proximity and work-home travel distance influence the frequency of for-home (grocery) and out-of-home (full service and fast food restaurants) food purchase for workers in Polk County?

ii) Does density of the food outlets and food service places along workers daily
work travel routes influence food purchasing behavior?

The questions that will enable this study to meet the second objective include:

i) Is a self-reporting mechanism/tool a reliable method for collecting spatial data to analyze access to the food environment?

ii) What is the effectiveness of facilitated-Volunteered Geographic Information as a method for data collection?

**Definitions of Terms Used**

The *community food environment* refers to the food options available and accessible within a specified geographic extent. In this case, *environment* is the space outside the person, the physical setting in which behavior takes place (Sallis & Owen, 2002). Food environment studies look at the availability of healthy foods within a community as well as price affordability and how easily community residents can access these foods (Maddock, 2004; Kipke et al., 2007). The food environment is made up of food stores, restaurants, worksites and schools (Glanz et al., 2005; McKinnon et al., 2009; Reidpath et al., 2002). Food stores include grocery stores, supermarkets, specialty stores, farmers markets and food pantries. Restaurants include fast food and full service restaurants; and the food environment in schools and work-sites include food options available in cafeterias, vending machines and snack shops (McKinnon et al., 2009).

While some studies include the home environment as an integral part of the food environment, for the purposes of this research, the food environment will focus on the
environment outside the home. Of particular interest in this study is access to grocery stores and both full-service and limited service (fast food) restaurants. Measurement of the number of food stores and food service places, type of food store and density will be used to characterize the food environment in the study area.

*Geospatial* is a term used to refer to data or information that identifies the geographic location of features and boundaries on Earth, such as natural or constructed features, oceans, and more. Spatial data is usually stored as coordinates and topology, and is data that can be mapped. Spatial data is often accessed, manipulated or analyzed through Geographic Information Systems (GIS) (Webopedia, 2009).

*Self-Reporting Mechanism* is a tool or instrument, such as a survey or questionnaire, where individuals/respondents voluntarily provide specific information based on a set of questions provided, without the mediation or presence of an interviewer. Frequently used in the Social Sciences, self-reporting helps to capture information directly from an particular group of interest, enabling researchers to gather valuable data free of observer/researcher bias.

**Contributions and Importance of the Study**

Through land use and urban development planning processes, planners can act to create communities that promote healthy behaviors (Handy & Clifton, 2006) and impact health outcomes by influencing the nature of access to food resources through public policy interventions (James et al. 1997). Land use and transportation planning decisions are central to creating healthy communities and environments that encourage and sustain health-
promoting behaviors. By determining the location, intensity and type of development in an urban area and the provision of infrastructure and services that link urban activities, these two planning domains can act to support healthy communities by increasing access to food resources (James et al. 1997, Sharp 1999).

By investigating workers interaction with the food environment along their work travel routes, this study contributes to the ongoing discussion about the environmental impacts on nutrition behavior. It provides an important link in food environment studies, which have so far been primarily focused on residential and workplace food environments. Also, the proposed public participation geospatial tool is an important addition to the pool of instruments and methodologies that capture first-person spatial information from both trained experts and contributors who are untrained in the cartographic and geographic sciences. Public participation strategies encourage community-based problem-solving strategies and promote collaborative, multi-sector solutions to address the need for more accessible food resources. The participatory methodology presented here will enable and encourage different community stakeholders to be involved in the contribution, development and interpretation of community knowledge. This tool allows these stakeholders to be engaged in the community planning process to advocate for design and transportation alternatives that foster better and healthier communities.
CHAPTER 2.

DEVELOPMENT OF A CONCEPTUAL FRAMEWORK

AND REVIEW OF LITERATURE

This chapter addresses the two main themes that form the basis for this study. First, a theoretical and conceptual framework is established from available literature, and is used as the foundation for investigating the food environment along travel routes. The literature review draws mainly from the fields of urban and transportation planning, and health promotion and human nutrition. Important themes in the review include a detailed look at the factors that have contributed to the change in trends in travel and food-purchasing behavior among commuters, as well as an overview of elements of the built environment and land use decisions that impact access to healthy food. The review also takes a historical look at the grocery industry, including concerns over food availability for different segments of the population. A discussion on the importance of public participation in the planning process will begin the second half of this chapter. This is followed by a look at how participatory planning methods have been successfully coupled with geospatial technologies, to develop digital methodologies that are used to optimize the role of the public in the planning process.
Towards a Social Ecological Model for Understanding the Food Environment

The food environment encompasses two levels of interaction: one, an individual level, which includes the cognitive, normative, biological and demographic factors that underscore the motivations, self-efficacy and outcome expectations that shape and determine eating behaviors (Story et al., 2008; Stokols, 2003; Hoehner et al., 2003). There are also spatial, or environmental elements on the community level that include features of the built environment and urban form, which motivate individual behavior and influence choice. These different levels of interaction demonstrate that the complex attributes of health and nutritional behavior cannot be fully appreciated through a single schema. An approach that considers multiple levels of influence in the connections between people and their environment is required, and would be useful in guiding research into food environment and intervention efforts that focus on accessibility to healthier food resources.

The social ecological model, developed in the fields of behavioral health and psychology, has been used widely to categorize the numerous linkages and factors that impact an individual’s behavior. This model provides a good approach to understand the concept of the food environment used in this study. It focuses attention on the connections between people and their environment, for the purpose of drawing out the environmental causes of behavior and identifying environmental interventions that can be useful for food access planning (McLeroy et al., 1988). Four assumptions underlie the social ecological approach. The first, identified by Stokols (1996), is that health is influenced by multiple facets of the physical and social environments, as well as personal attributes. Secondly,
environments are multi-dimensional – they can be social or physical, actual or perceived, discrete attributes or constructs (Stokols, 1996; Sallis & Owen, 2002). Third, human-environment interactions can be described at different levels of aggregation: individual, family, work or institutional organizations, communities or whole populations. The fourth assumption is that person-environment transactions occur in cycles in which people influence their settings, and these changed settings then act to influence behavior (Stokols, 1996).

This type of holistic approach in investigating factors of the built environment that influence health is not a stranger within the field of urban planning. During the early days of planning, the negative effects of the rapid industrialization of 19th century Europe and the United States propelled many early planners to see the need for comprehensive, holistic and multi-level solutions to the housing and sanitation, poverty, hunger and health problems that faced the newly industrializing West. Urban planning as a discipline was historically built upon the premise that the built environment should protect the health, safety and welfare of the populations that live within the urban setting. As migration, trade and industrialization brought sweeping changes to the size, form and demographics in European and American cities, these planners role took on a more inter-disciplinary approach in order to deal with the myriad problems of the burgeoning urban population. Other planners, notably Ebenezer Howard, made a concerted effort to include the health-promoting design aspects in their concepts of the ideal city. In his 1902 work, Garden Cities of Tomorrow, Howard lays out the blue print of a city that places social, economic and personal wellbeing at the center of its agenda (cited in Frank et al., 2003). Other examples of this multi-system approaches to planning include the urban greening movement of the mid-nineteenth century and the housing reform movement of 1900-1914. Proponents of the urban greening movement such
as Frederick Law Olmsted believed that parks and green spaces would greatly benefit urban residents, particularly the urban poor (Laurie, 1979). By allowing them to escape their polluted neighborhoods and spend time in the clean air and calming environment of the parks, Olmsted believed that the quality of life of urban residents would be enhanced by improving their physical health. In the same way, housing reformers of the early twentieth century made the case for public health on the grounds that better sanitation would improve health by purifying the local atmosphere (Frank et al., 2003). Reformers of this period such as Lawrence Veiller believed that housing problems and public health problems were causatively linked, and proposed that architectural and design improvements of the New York tenement housing and streets would improve public health.

These early planners demonstrated how a multi-system approach to urban planning can promote and highlight alternatives for achieving the goal of maintaining a healthy population. Planning for healthy communities today should not only be narrowly focused on to the traditional planning roles such as zoning and land use planning, but should expand to incorporate all levels of interaction that include individual/intrapersonal factors, interpersonal processes and primary groups, community, organizational and public policy factors (McLeroy et al., 1988; Story et al., 2008). For food environment research, attention should be paid to individual and community factors that influence food store availability in neighborhoods and along transportation routes. Researchers should expand their horizons, moving towards more inclusive ecologic models that recognize the importance of both physical and social environments as determinants of health (Ewing et al., 2003).
Trends in Travel Behavior

In the 1950s, the public and elected officials considered highway congestion the main urban transportation problem. Rapid growth of automobile ownership and the suburbanization of the population produced congestion on road networks in and around central business districts (CBDs) during peak periods. Cities and counties tried to reduce this congestion by expanding arterial streets and building expressways and parkways. However, these new and expanded facilities encouraged more suburban growth and rapidly became congested as well. As a result, highly accessible, high-speed freeways were proposed as a solution to congestion. Highways were regarded as a public good that should be built and maintained by government to serve the most ‘democratic’ of transportation choices - the automobile (Foster, 1992).

The Highway Trust Fund Act, passed simultaneously with the Interstate Highway Act, authorized 40,650 miles (later expanded to 42,796 miles) of Interstate and National Defense Highways to be built by 1972 and provided $24.8 billion in funds for the period from 1957 to 1969 (Altshuler et al. 1981; Federal Highway Administration 1977). Economic growth during the 1950s made financing such a large, peacetime public works project feasible. The interstate highway system biased transportation investments in favor of urban freeways, reducing the ability of public transit modes to compete with the automobile. The interstate highway system facilitated the suburbanization of households and jobs, creating origins and destinations that were difficult for conventional transit to serve. This investment in road networks created a large market for cars, the largest of which was in cities and urban areas.
Not only were they the most rapidly growing parts of the country, but many urban households were reaping the benefits of an expanding economy, and were able to consider investment in their own automobiles (Altshuler et al. 1981). In the forty years between then and now, the use of private vehicle as a means of travel, especially for work-related travel, has more than tripled (Federal Highway Administration, 2008). According to the 2000 census, the number of vehicles per household and per worker has increased tremendously. Between 1960 and 2000, the U.S. added 102 million households, 124 million vehicles and 64 million workers (U.S Census Bureau, 2000). The increase in households and vehicles far exceeded the increase in workers and population. On average, two vehicles are added to the household vehicle pool for every additional worker, making the average household of 2 working adults owning 3 to 4 vehicles (Transportation Research Board, 2006).

The private vehicle, especially driven alone to work, is the mode of choice for most Americans living in large metropolitan areas. In every major metro area, workers who drove alone to work increased in numbers and share in the last 40 years. As driving alone to work became more common, use of other modes such as carpooling, public transportation, walking, and bicycling all declined. In 2000, three-quarters of commuters drove alone to work, while only 12.2 percent reported carpooling, followed by 4.7 percent using public transit, and 2.9 percent walking.. Nearly 13 million more workers drove alone in 2000 than did in 1990. One of the big surprises in the 2000 U.S census was the continuing decline of carpooling as a means of travel to work, in relation to driving alone. Average occupancy for private vehicle modes to work is 1.08 persons per vehicle.

American workers are spending more time getting to work than ever before. The change in travel time between 1990 and 2000 shows workers in major MSAs increasingly
traveling 45 and 60 minutes or more on a one-way trip to their places of employment. A declining proportion of workers have short commutes (less than 15 minutes) in the large metro areas. According to the 2000 census, 21 percent of workers commuted more than 45 minutes to work, up from only 11 percent in 1990 (Transportation Research Board, 2006).

Underlying the increase in travel and these changes in travel patterns are important shifts in conditions that shape the travel environment and levels of travel demand, independent of the addition of highway capacity. The pattern of commutes in America is affected by the supply and location of jobs and housing, the time and convenience of various modes of commuting and worker characteristics. One of the greatest shifts in worker characteristics that precipitated changes in travel patterns was the entrance of women into the workforce. Seventy percent of women work today compared to just 38 percent in 1960, and only 20 percent at the beginning of the 20th century. The shift from single-earner to dual-earner families brought about changes in household dynamics fueled by the rise in household income, household vehicle ownership, rise in trip chaining and the decline in multi-occupant vehicles (Transportation Research Board, 2006). From the longer vantage point of history, the entrance of large numbers of women into the workforce in the 20th century is as profound a change as the move from farm to factory in the 19th century (Foster, 1992). The entry of women into the workforce in such large numbers also increased demand for market provision of the types of services they traditionally performed, such as cooking, cleaning and child care (Schlosser, 2002).

The work trip is often the longest distance traveled, and many work locations provide a sphere of activity that anchors some of the travel, either in stops made between home and work or in trips made around the workplace. A generation ago, three-quarters of the money
used to buy food in the United States was spent to prepare meals at home. Today about half of the money used to buy food is spent at full service or fast food restaurants. The character of the work trip for women is also significantly different than that of their male counterparts. Stops to child care centers to drop off or pick up children, to the grocery store to purchase food items or to the restaurant to get a quick family meal have become part of the daily activity of working women as they try to accommodate all their duties and responsibilities into their schedule.

The development of food and shopping facilities along major travel routes was partly in response to the growing demand for easily accessible and readily available resources for the working women, as well as other busy commuters. The availability of these services along major travel routes enables commuters to save on time and transport costs by coupling their work trips with personal or household-related trips to run errands to purchase food, or stop at stores and restaurants without making a major diversion from the work trip. This is not only true for those who drive personal autos, but also for those who use public transport, as many bus routes are now designed to pick up and drop off commuters at these highway commercial nodes and centers. These commuter-oriented shopping centers provide a very important food shopping opportunity for road users, and make up a large part of their food environment.

**The Impact of Planning Decisions on Community Design**

The built environment, that physical form of our cities, or the “amalgamation of individual elements of the towns and cities in which we live, work, play and travel” (Frank et al., 2004), plays an important role in determining access to resources for healthy living. Land use regulations determine the spatial arrangement of residential, commercial and industrial
areas, as well as green and recreational spaces. The basic land use patterns in an area define how and where these structures are arrayed, determining to a large degree, how interconnected or disjointed places are to one another (Frank, et al. 2004). Land use and zoning practices are therefore important considerations in the study of personal and environmental correlates of diet-related behaviors.

The interaction between the built environment and its users is a highly complex relationship that results from the interplay of multiple physical, interpersonal, organizational and socio-cultural factors. In urban areas, this relationship is largely dependent on two main factors: the land use patterns which dictate the location of activities across space, and the transportation systems that link one place to another (Stokols et al., 2003). The spatial location of infrastructure and facilities such as parks and recreation areas, trails, sidewalks, supermarkets and food outlets largely determines who will patronize them, the frequency of visits and the types of goods and services that will be available to those patrons. These spatial elements further determine access to opportunities for physical activity and healthy eating, which in turn determine individual and community nutrition and health behavior.

Over the last 40 years, urban form has steadily evolved under the direction of land use and zoning policies and practices. Prior to 1970, cities were mostly compact, centralized and highly inter-dependent. Since then, the urban locale has become highly decentralized, disconnected and expansive. The separation of land uses that began in the late 1960s led to almost total segregation of commercial, industrial and residential areas, which in turn led to most urban areas being less walkable and sprawling (Handy & Clifton, 2006). While initially designed for the purpose of increasing utility and maximizing the health and welfare of urban dwellers, these land use patterns precipitated changes in density, concentration, centrality,
diversity, mixed uses, connectivity and proximity (Ewing & McCann, 2003).

Zoning is the legal tool of local government to specify how land will be used and makes up the crux of how modern day cities are planned. At the turn of the twentieth century, zoning was seen as a critical tool in the efforts to protect the health, safety and wellbeing of the urban populace. Zoning practices not only created districts by type of use, but also segregated each use by type of housing or structure. Particularly prevalent in residential zoning, zoning practices mainly catered for the needs of the upper and middle classes, rather than the working and the migrant poor (Marcuse, 1977). As single family housing was segregated from multi-family housing under the assertion that the two types of housing are qualitatively different, neighborhoods with noticeably different characteristics were born, not only architecturally, but also in the type of resident that was attracted to them (Frank et al, 2003). The creation and protection of the ‘decentralized, decongested, leafy residential neighborhoods and the healthy suburban environment’ (Marcuse, 1977) has unwittingly become the trademark of zoning laws in the latter part of the twentieth and early part of the twenty first centuries.

This separation of use and type of housing led to the steady ‘flight’ of resources from neighborhoods that are deemed sub-standard, undesirable, high density or poor. Central cities, which typically have higher densities and older infrastructure, have taken the brunt of this diversion of funds, as new investment in business, housing and infrastructure seeks out the more affluent exurban and suburban neighborhoods. The continued and persistent disinvestment in city neighborhoods has effectively driven down the value of these neighborhoods, and down-graded the quality of goods and services that are available to residents. As contiguous development has steadily given way to leap-frog development
patterns and unlimited outward expansion, urban and exurban neighborhoods across the U.S. have experienced a shift in the strength and vibrancy of activity centers and downtown areas, accessibility of the street network, residential density and the mix of land use at the neighborhood level (Ewing et al., 2003).

The problem of land use separation is often compounded by the layout and design of the local transportation networks. Most cities have traditionally adopted the concept of a street hierarchy in their land development codes where streets are distinguished by the degree to which they serve access or movement functions (ASCE et al., 1990; Handy & Clifton, 2006). At one end of the hierarchy are freeways, serving a movement function; at the other are cul-de-sacs, serving an access function (Handy & Clifton, 2006). Although this approach means lower levels of traffic within neighborhoods, it also reduces the quality of the walking environment and discourages active travel. Wider streets within residential areas increase the tendency of drivers to speed, making walking more dangerous, reducing their desirability for walking and bicycling (Southworth & Ben-Joseph, 1997).

Barriers to access of food resources affect people of lower socio-economic status (SES) more adversely than those in higher SES. Although land uses in central city neighborhoods are typically less separated than those in suburban neighborhoods, and residents are much closer in distance to possible destinations and enjoy more walkable environments, these neighborhoods also tend to be poorer and suffer from infrastructural disinvestment, higher crime rates and poorly maintained structures (Handy & Clifton, 2006). This disinvestment and resource flight has left many of these older, central city neighborhoods with limited options for physical activity and healthy food (Morland et al., 2006). People with lower SES also have more limited access to personal vehicles, which
makes them largely dependent on resources that are within closer proximity to their homes and within walking distance or along public transportation routes (Morland et al., 2002). As land use regulations and market forces interact to determine the location and type of food stores operating in an area, many lower income neighborhoods are left with a disproportionate number of poorer quality food stores than higher income neighborhoods (Morland et al., 2006; Algert et al., 2006; Moore & Diez Roux, 2006; Powell et al., 2007).

**Understanding the Food Environment**

The study and measurement of the food environment and its effects on dietary behavior is a relatively new field of inquiry. The food environment can be broadly defined to include home, community and media and information environments though many studies focusing on the community food environment limit themselves to community-level food resources such as food stores, restaurants, worksites and schools (Glanz et al., 2005; McKinnon et al., 2009). Our physical, economic, political, and socio-cultural environments also have a large role to play on food environments and determine opportunities for healthy and unhealthy choices and behaviors, the costs related to them and rules and regulations that may influence eating and exercise behavior (Brug, Lenthe & Kremers, 2006).

Measurement of food and nutrition environments include all potential determinants of nutrition behavior such as cognition, attitudes, beliefs and skills as well as physical environment and policy factors (Glanz, 2009). Investigations into the associations between the food environment, diet and health outcomes have become more mainstream during the last decade, and more so over the last few years. Studies have shown that access to food
stores and food outlets (such as restaurants) is influenced by neighborhood characteristics including race/ethnicity and socio-economic status (Soonam & MacIntyre, 1993; Morland, et al., 2002; Zenk et al., 2005; Moore & Diez Roux, 2006). Resident flight from the central city to the suburbs has not only precipitated infrastructural disinvestment in the central cities, but has also led to relocation of supermarkets and grocery stores to suburbs and along major highways, as the stores became more centralized and search out lower rents and larger lots in the suburban belts (Morland et al., 2002). Many central city residents face disproportionately low access to healthy foods as stores relocate away from the central city. The situation is exacerbated by the prevalence of fewer and smaller, higher priced grocery or convenience stores in lower income central city areas that do not have the same choice of quality, price and selection as those found in more suburban supermarkets or in upper-income urban areas. This lack of large supermarkets is of concern because they generally offer a wider variety of higher-quality food at more affordable prices than smaller grocery stores (Story et al., 2008).

**Availability and Access to Healthy Food in Urban Areas**

Research has shown that healthy food is more expensive and less readily available in lower income neighborhoods than in affluent ones (MacIntyre et al., 2005; Morland et al., 2002). Studies conducted in East Los Angeles, Detroit and New Orleans (Powell et al., 2007; Zenk et al., 2005;) found that people living in low-income, predominantly black neighborhoods had significantly more exposure to fast food restaurants than those living in more affluent, predominantly white neighborhoods. Studies in Glasgow, Scotland, showed that there was a higher density of McDonald's fast food outlets per thousand population in more economically deprived areas than in wealthier neighborhoods (Cummins & MacIntyre,
Conversely, there were fewer chain supermarkets and grocery stores located in these neighborhoods than in affluent neighborhoods. In Detroit, chain supermarkets in black neighborhoods were fewer by 52% than those in their counterpart white neighborhoods, even after controlling for income (Zenk et al., 2005). For consumers who reside in low income, poorer areas with reduced mobility due to lack of personal transportation and reduced access to public transportation outside city limits, the lower access to grocery stores means a reduction in food choice. Areas where healthy food is expensive and relatively unavailable, coupled with transportation constraints of carless residents or residents with reduced mobility to access food options outside of their immediate locality are termed ‘food deserts’ (Wrigley, 2002; Whitehead, 1998; Chung & Myers, 1999; Gottlieb et al., 1996; Short et al., 2007). Food deserts are not only a problem in central cities, but also persist in rural areas (Story et al., 2008). In a study conducted to understand the distribution of counties where residents have low access to large food retailers (where residents had to travel greater than 10 miles to a food retailer), data shows that 418 rural counties across the country were food deserts and have high poverty rates (Morton & Blanchard, 2007).

On the other hand, less restrictive zoning in low-income areas may have contributed to an abundance of unhealthy food options, particularly fast food (Block, et al. 2004, Morland et al., 2002). Although fast food restaurants aren’t usually labeled as undesirable, living close to such restaurants may be undesirable from the standpoint of obesity prevention if fast food restaurants encourage over-consumption of large quantities of high calorie foods and beverages. The abundance of fast food restaurants affects other vulnerable populations as well. A recent study shows that fast food restaurants tend to locate around schools, targeting their products to children and adolescents (Austin et al. 2005). Many affluent neighborhoods
tend to restrict the number and location of these outlets through the formal land use planning process, often citing design issues about these establishments not fitting into neighborhood characters and raising concerns about the additional automobile traffic generated, which effectively keeps these establishments away.

A Historical Look at the Grocery Store Industry

The current trend in retail restructuring that has persisted from the 1980s is a primary factor influencing the availability of healthy and affordable food in urban areas. As early as the 1920s, the individual retailer was being squeezed out by large multiple stores who had the advantages of economies of scale in buying and could offer a lower price point to consumers. The single retailer could not compete with the economies of specialization in administration and economies of standardization in production enjoyed by the large food retail corporation. The bulk and variety of goods offered by large retailers as well as the efficient distribution of a network of shops establishing their presence in the market edged the individual grocer out of the market (Mayo, 1993).

The food supply chain that moves products from the farm to the consumer’s table has been marked by systemic shifts in the production, preparation and marketing policies within the retail sector. The movement from the corner marketplace to the general store, the introduction of the grocery store and ultimately to national chain-store companies and supermarkets is attributable to the ability to standardize products and streamline the production and distribution processes in order to improve efficiency and maximize profits. With the change in consumption patterns and economic boom in the post-war years, the mechanizations of food selling had to change. No one shop could attract and maintain a
constant and loyal following of consumers. The food stores needed to be where the consumer was – near their homes and on their way to work (Seth & Randall, 2001).

During the 1980s and early 1990s, the re-organization of food retail space into these larger mega-stores and super-centers that covered more square-footage and offered a greater variety of foods led to diminished numbers of grocery stores in central city neighborhoods (Cummins & MacIntyre, 1999). As more stores moved to edge of the city or to newly zoned suburban commercial centers, these food outlets relocated where there is most potential customers both during the day and evenings, and this demand was found higher in retail, transport and commercial centers, areas with high traffic density such as along arterial roads with much passing traffic, and major interstate highways.

As the supermarket industry has become increasingly more centralized; the total number of food stores has declined while the average store size has steadily increased (Dunkely et al., 2004). The current dominance of the large-scale corporations on the food market landscape was precipitated by the high competition in the food retail sector which phased out smaller market merchants who lacked the size to compete against large retail corporations. Not only were they out-sized, the corner market could hardly meet the need to increase supply to meet growing consumer needs and to maintain the necessary service levels to keep profits coming in (Mayo, 1993). The surviving corner grocery stores in the central city had to increase their prices and change their products from the high price-point fruits and vegetables to cheaper processed foods in order to thrive (Cummins & MacIntyre, 2002).

As these new larger stores are disproportionately located in suburban areas, and along highways, existing stores in poorer urban areas are closed or sold. The result is an urban grocery store gap: low income areas have smaller, higher priced groceries or convenience
stores that do not have the same choice of quality, price and selection as found in more suburban supermarkets (Chung & Myers, 1999; Gottlieb et al., 1996) or in upper-income urban areas (Horowitz et al. 2004). As a result, many lower income neighborhoods tend to have a scarcity of healthy food options, such as supermarkets and grocery stores that carry good quality fresh produce.

A Participatory Approach to Food Environment Studies

A Historical Look at Public Participation GIS

Prior to the 1950s, community planning was the exclusive domain of the city planning department or planning agency. Its function was clearly defined: to provide for the orderly and systematic growth of the community (Burke, 1979). These agencies were charged with the responsibility of directing deliberate and conscious efforts to bring about social change using methods that are concerned with developing ways to either preserve the present to secure the future, or altering the present to preserve the future. This approach used the rational form of analysis for selecting the best means to achieve pre-determined ends. The format followed a pattern in which the planner, guided by a goal, would set out the range of alternative solutions or possible ways of achieving the goal, detailing and enumerating the consequences of each alternative. The best alternative would then be selected by weighing and ranking each alternative against the others (Dalton, 1986).

The role of the planner in this paradigm was as a professional, whose expert advice and opinion reflected the needs and best interests of the community. Planners were
technocrats who spent most of their day gathering and analyzing data, and producing alternatives which would be used to inform decision-makers on the best course of action for the community. Planners were considered to be objective and detached outsiders who were not to let their views and ethics get too involved in the process, to keep information objective and complete (Forester, 1989). This top-down structure of the rational comprehensive planning model gave the community a very minimal role to play in making decisions about the future of the community.

Competing paradigms emerged in the 1950s and 1960s to oppose the applicability of the rational model, arguing that the rational model would only work when the problem is well defined, there is only one actor, the setting is closed, the decision-makers office has perfect information and time is infinite (Forester, 1989). Since this setting is unrealistic, pure rationality was therefore unrealistic as well. Opponents of the centralized decision-making of the rational model proposed more inclusionary and communicative models that valued more open information-sharing with the public, and put decision-making power in the hands of the citizenry. They proposed decentralized strategies which emphasized the importance of the democratic process in public decision-making, and sought to change who the stake holders were and the process of making decisions on community issues (Brooks, 2002). No longer was the planner a detached expert, whose main role was to set community development goals, evaluate all possible alternatives and then select the best option. Now the role of the planner was to facilitate a public, democratized form of decision-making, one which recast many community planning issues as agenda to be debated and agreed upon by a pluralized public, rather than exclusively by an objective technocrat (Peattie, 1963; Healey, 1996).
Technology in this new planning paradigm was a useful tool to be employed for the collective benefit of a diverse pool of stakeholders rather than solely for the trained expert (Brooks, 2002). In the participatory planning model, technology is used as a veritable tool in different stages of the decision making process, from problem presentation, information gathering, facilitating and guiding deliberations, funneling opinions and finally, to plan formulation. One of the technologies that has had a long and close relationship with the planning profession has been Geographic Information Science (GIS). GIS is a computing application capable of creating, storing, manipulating, visualizing, and analyzing geographic information (Goodchild, 2000). The unique feature of GIS is that it enables planners and other professionals to work with data that is locationally referenced, and provides an avenue for the visualization and analysis of information in its spatial context. Over the last two decades, GIS has evolved from being a complex, custom-designed luxury that only a few well-placed institutions could afford, to being a mainstream off-the-shelf program for any number of public and private entities. As GIS technology is increasingly used to represent and analyze society issues, its role has shifted from being just a tool designed to solve one aspect of a problem to being an important part of the social process involved in decision making (Sheppard, 1995). A planner can use GIS to elaborate a community problem, present a solution, or augment a position, bridging the gap between research and practice by creating problem-solving options that give the process a greater meaning to stakeholders.

It is this benefit to the both the planning profession and to the communities with which planners work that prompted GIS professionals to put efforts towards improving access to GIS technology to a wider audience, especially those under-represented in the planning dialogue. In 1996, Public Participation GIS (PPGIS) was born at two meetings of
the National Center for Geographic Information and Analysis, where participants charted out the next era of GIS as one of inclusionary, democratized technology. The next frontier of GIS was outlined as one that would develop applications that would ground technical advancements in social and political contexts (Sieber, 2006). Participatory or inclusionary strategies in planning are aimed at the inclusion and acknowledgement of the different ways of knowing, valuing and giving meaning to lived experiences, offered by different members of the political and social community (Healey, 1996). As our communities increasingly become areas of fragmentation, with ‘bits and pieces’, ‘niches and nodes’ reflecting the disintegration of the social and political structure of society it becomes easier to neglect the needs and concerns of the least-advantaged within them (Healey, 1996). The idea behind PPGIS was to provide less privileged and marginalized groups in society the technology to empower their decision-making processes by enabling them to access and use the language and tools of experts (Obermeyer, 1998). The use of GIS and its correspondent and complementary tools enhances the process by capacity-building and management of social change, allowing users the expediency of its user-friendly interface while at the same time offering the versatility of diverse analytical abilities.

At the offset, the over-arching critique of the use of GIS as a technical application for social issues was that it was divorced from its socio-political context, reinforcing the positivist or rational ideal of the disembodied, objective and technical solutions derived through instrumental rationality. The development of a participatory form of GIS that includes a wide array of non-technical, geographically untrained contributors was essential, one that would ‘celebrate the multiplicity of geographical realities’ (Dunn, 2007; Sieber, 2006) and refocus the use of GIS towards being a more socially aware type of technology.
which gives greater privilege and legitimacy to local or indigenous spatial knowledge (Dunn, 2007). Participatory GIS was built upon the premise that there is relative fluidity in the sharing of data between producers and potential participants (Tulloch & Shapiro, 2003). This new direction was to be driven by the social and political contexts and issues facing the communities, using community-level knowledge and expertise to produce and interpret geographical information (Dunn, 2007). The expansion and advancement of PPGIS over the last few years has greatly increased accessibility to easy-to-use design and analysis software not only for technicians and academicians, but also to grass-root community groups, Community-Based Organizations (CBO) and other stakeholders across different landscapes.

**Online PPGIS: Innovation in Local Decision-Making**

The rise of the internet in the 1980s, and the now ubiquitous presence of the computer have greatly expanded the potential for creation of a GIS for public use. The availability of a variety of GIS systems via the web as well as easy accessibility of useable data has made online GIS a reality for both the GIS expert, the lay professional and the general public (Kingston et al., 2000). While traditional forms of public participation (such as charettes and town hall meetings) are at the mercy of a small vocal minority who often times hold extreme views on community planning and development issues, web-based public participation instruments offer a number of novel solutions. Via the web, a more diverse group of contributors with differing viewpoints can be solicited to participate in community issues, without the restrictions of meeting times or geographical meeting locations (Kingston et al., 2000). Access to the issues at hand is easily done through any location with internet access, is available at any time of day or night within a specified duration and allows participants to
provide information anonymously, making it easier for those with differing or strong opinions to voice them without the restrictions of public consultations.

In the mid-1990s, the increase in online participation technologies and the easier access to data precipitated the emergence of online mapping. At the time of development of these online mapping technologies, a major concern was that the public - generally untrained in geographic sciences - would not be able to deal with the complexities of digital cartography, fail to understand digital maps in aerial view or would have a hard time recognizing locations on a digital map (Obermeyer, 1998). However, free online mapping services such as MapQuest dispelled these fears, as users easily used the software to look up directions, search for and map various locations. As the major function of these initial online mapping systems was map-making, several other products provided the advanced spatial analysis and information processing functions of GIS. Infrastructural projects such as the Center for Spatially Integrated Social Sciences (CSISS) and Center for Spatial Information Science (CSIS) led the way in developing and disseminating online GIS. However, these GIS systems were mainly reliant on data collected and stored primarily by academic and governmental institutions, which was at times out-of-date and limited in scope (Obermeyer, 1998).

The need for location-based information that is timely and easily accessible precipitated the User Generated Content movement or what is more popularly known as Web 2.0. Web protocols that enabled users to access information on the web, as well as supply information to vendors through online forms precipitated this movement in the early 2000s (Goodchild, 2007). Using easily accessible, free online resources, any user with access to the internet can provide geographic information on any place on the earth’s surface, describing
features of varying size, make comments or describe experiences without being an ‘expert’ in any associated geographic discipline or technology. Widely used applications that employ this innovation include Flickr and Wikimapia, both of which allow users to upload pictures or make entries on any place on the earth’s surface by longitude or latitude. Google Maps also offers a free mapping services to the general public, providing satellite map views for any location worldwide, directions, city and town mapping, as well as local business searches. Additionally, by utilizing open source code, users can create dialogue boxes with information pertaining to a particular geographical point on their map (Purviss et al., 2006; Rey, 2008).

These democratized geospatial technologies which allow the public, untrained in the geographic and geospatial sciences, to provide their ideas and input about community planning and design issues are termed Volunteered Geographic Information (Goodchild, 2007). For the purposes of planning and community development, the ability to gather from local residents geographically referenced data about local issues opened up a plethora of possibilities for engaging and collaborating with the public on issues that concern and require the participation of community members. The development of digital mapping technologies, and access to free and easy-to-use online mapping services such as Google Maps, has made an avenue for researchers through which they can easily source valuable information from both technical and non-technical contributors.
Conclusion

The highly complex nature of nutritional behavior demands solutions that are at once sophisticated, yet simple enough to address a wide number of concerns, as well as offer easy applicability in different situations. In food environment studies, both technical and non-technical recommendations should provide community stakeholders with the confidence that their implementation will provide the community with a better, more secure food system. This chapter has reviewed how land use and zoning laws can direct the location of food resources in a community, and how this in turn affects access and availability of healthy food alternatives for community members. The need to develop new methodologies that can capture, in real time, how community members interact with the food environment in their residential and work-site neighborhoods as well as along travel routes, becomes vitally important for directing efforts that are geared towards understanding the needs of the community to ensure food security. Using public participation techniques to gather first hand spatial information enables gathering of data can be analyzed and used bring together several different stakeholders to the decision-making table.
CHAPTER 3.

METHODS AND PROCEDURES

Introduction

Methodology can be referred to as the way in which we approach problems and seek answer (Taylor & Bogdan, 1998). The theoretical perspective in this research study is largely based on participatory or inclusionary knowledge claims, that is, developing an understanding and presenting social phenomena from the perspective of the groups or populations who experience it. Participatory or inclusionary modes of knowledge in most cases examine how the world is experienced by marginalized or under-represented sub-groups of the population.

While the sample group in this case is not marginalized in the traditional sense of the word (traditionally, marginalization refers to the rendering of an individual or group powerless in a political or economic capacity), commuters have, until now, been largely un-represented in the literature on the food environment. For the millions of commuters around the country, the food establishments available alongside their daily travel routes make up an important part of their food shopping resources, and their views and experiences could offer a depth of insight for planning, transportation, health and business sectors. But even as food environment research advances and study questions are broadened and more populations are considered, this area of study is still largely hampered by the lack of proven methodologies
that have the capability to adequately quantify user interaction with the food environment, and measure accessibility and availability of healthy foods.

With that perspective in mind, this chapter is divided into two main themes: First, it starts off with a discussion of the technology used in the development of the facilitated Volunteered Geographic Information (f-VGI) methodology, and gives insightful information into how this methodology can be utilized to capture valuable, first-hand user information. This chapter will also explore the research design of this study, discussing the rationale behind the selection of a site, introduce the participants of the study, discuss the methods used for data collection, and present the concerns that arose from utilizing those data collection instruments and methods.

**Developing a Methodology: Facilitated Volunteered Geographic Information**

In February 2005, Google released a free mapping service called GoogleMaps to the public. Using GoogleMaps, one could search for any location on earth free of charge, as well as view satellite images of any place globally. At the same time, unannounced, Google provided a way for users to manipulate the code of GoogleMaps by giving public access to their shared source code (or application programming interfaces – APIs). By doing this, Google effectively altered digital mapping capabilities, and opened the door on the online mapping revolution that enabled users to create and develop their own maps and publish them on any internet site, while keeping the GoogleMaps interface (Purvis et al., 2006). This enables both technical and non-technical users to develop geo-enabled devices that can
collect and disseminate data with spatial attributes and altered how data is gathered by offering researchers a new avenue through which they could collect timely, user-generated data (Purvis et al., 2006).

Since GoogleMaps and later Wikimapia, web services that support user-generated and user-modified maps and spatial data have continued to emerge at a rapid pace, and allow users to create their own maps online or contribute to and edit geographic information published by others. Users may import or ‘mash up’ shared source codes into their own web mapping services, or use markup languages to ‘geotag’ online content such as photographs with information about their geographic location. This technology provides a number of utilities for manipulating maps and adding content to the map through a variety of services, allowing you to create robust map applications on one’s website.

User-generated spatial data is used for two main purposes – cartography and data collection. Users with an emphasis on cartography/mapping are usually more inclined towards manipulating and creating more accurate digital cartographic data. A focus on data collection leans towards an emphasis on the information, highlighting shifts in the forms of spatial information available and in the creation processes and the ways the information is used. Access to free and easy-to-use online mapping services has prompted both technical and non-technical contributors to provide information on a wide variety of subjects, as diverse as finding the best location for sushi or providing local government departments with information on broken-down infrastructure in local neighborhoods. This geo-spatial data, called Volunteered Geographic Information or VGI, can be created in a number of diverse contexts, and in formats that are either intentionally created and shared, or sometimes may be collected from ‘producers’ without their awareness or permission (Sieber 2007). In most
cases, users provide voluntary, unsolicited information, that is, users provide information on their own accord, without prompting. When a predefined criteria is established that prompts users to respond to a set of queries or directives that in turn determine the range or type of information to be provided, then this is termed structured or facilitated Volunteered Geographic Information or f-VGI (Seeger, 2008). In f-VGI, a facilitator with a pre-defined agenda such as a community design process, recruits volunteers to provide information on a specified geographic extent. This recruitment of interested users who are well versed in the features under consideration within the local community makes a difference in the design or planning process. They provide a local dimension, a knowledge or wisdom that may not be available when using only experts, who are in most cases, outsiders (Seeger, 2008; Maue, 2007).

**Why VGI?**

With the recent developments in web and computer technology, the possibilities to share information have greatly expanded, as has the need for new information sources that offer interesting and varied points of view on different subjects ranging from environmental conservation, climate change and sustainable agricultural practices, to where to purchase the next best thing in fashion and design. With minimal effort, internet users can now transform themselves from being mere information users to information producers, voluntarily sharing their knowledge and experience with other internet users.

Citizens can provide valuable information by applying local and sectoral knowledge not only to local problems, but to national and global issues as well. Information supplied is not only factual and real to the producers, it also bears a distinct spatiotemporal component.
that comes from the lived experiences of the producers, which is the essence of Volunteer Geographic Information. With VGI, information producers link their knowledge to the local impact of the issues at hand, through their experiences and interpretations, and provide a rich etiology.

**Enabling Technologies**

Many technologies - some cutting edge and revolutionary, and some common, everyday improvements - were needed to enable the development of the f-VGI methodology used in this pilot study. The prominence of the computer in today’s lifestyle, and the expansion of the World Wide Web provided a rich environment for development of online digital technologies. Early use of the web was a one-way interaction, allowing users to surf a website and view information, but would not allow users to add to it without the specialized knowledge and permissions required for website development (Goodchild, 2007). Later, the development of protocols that allowed information to be added to online databases through the use of forms allowed companies to expand their information base (especially for marketing purposes) and gave users the capability to add content to websites, marking the beginning of user-generated content trend.

Initially, websites were simple and predominantly text only. The development of the personal computer brought along with it innovations such as high-quality graphics, which have been utilized for dynamic visualization of two and three-dimensional objects essential for digital mapping. Development of graphics software has anchored digital cartography, and made highly sophisticated satellite imagery possible and easily accessible through practically any personal computer.
Another technology that has greatly enabled VGI is geo-referencing. Geo-referencing refers to the process of defining a location on the earth’s surface using map projections or coordinate systems. GIS largely relies on geo-referencing using a number of well-defined and interoperable systems such as longitude-latitude coordinates or Universal Transverse Mercator (UTM). For many people, using geographic coordinates is anything but a run-of-the-mill, common-place activity. The development of several user-friendly tools has permitted this specialized knowledge to be transformed into a form that is easily adaptable for everyday use. Today, many handheld mobile devices such as cell phones are equipped with Global Positioning Systems (GPS) that allow street names or physical addresses and locations to be recorded in any standard co-ordinate system. This innovation has enabled non-technical users to provide important geographic data valuable for researchers through devices that that automatically tag locations with co-ordinates. In VGI, users can record the co-ordinates of a specific location by the simply clicking on the digital map, which can then be uploaded into GIS software for spatial analysis.

**Research Design**

**Site Selection**

The process of selecting a site to conduct this pilot study was governed by a number of factors. Foremost, the site needed to meet certain demographic and physical criteria which included having a large population, cover a large geographical area and be highly urbanized. The reason for conducting this study in an urban area is because until very recently, the food environment in urban areas has been largely ignored, with the general consensus being that
food issues are specifically the domain of agricultural and rural studies. However, the effects of food access in urban areas are pervasive and have many implications for urban life, which makes it increasingly important to study urban food environments. Also, conducting this study in a large, urban area would ensure there is diversity in population demographics. Secondly, because the study was designed to meet two objectives, i.e., to test the effectiveness of a web-based f-VGI survey instrument, and to use the data collected through this method to assess the food environment - it was important to select a site where there was a wide range of participants’ potential work travel routes and food outlets to increase variation in data for analysis. The site therefore had to have a well developed road transportation network that offered a wide array of route options to drivers and commuters on their daily work trip.

The selection process was done in three stages. First, a suitable county within the state of Iowa was selected. After looking at a variety of options, Polk County was chosen for this study. The selection of Polk County was based upon two main factors. Foremost, Polk County is Iowa’s most populous and urbanized county. With a population of 424,778 (U.S Census Bureau, 2008), Polk County holds about 15% of the state’s population. Des Moines serves as both the county seat and state’s capital and has a population of 196,998 (U.S Census Bureau, 2007). Unlike many of the counties in Iowa, Polk County is almost entirely urbanized. The Des Moines Metropolitan area (also known as the Des Moines – West Des Moines Metropolitan Statistical Area) is mainly made up of the cities of Des Moines and West Des Moines, as well as the smaller cities of Altoona, Ankeny, Clive, Indianola, Johnston, Urbandale and Waukee. Although the Des Moines Metropolitan Area covers a geographical area that falls in 5 central-Iowa counties, for this study we were only concerned
with that part that falls within the boundaries of Polk County.

Next, three neighborhoods in Polk County were chosen based on the socio-economic characteristics of the neighborhoods. For this pilot study, neighborhoods were assigned the same boundaries as block groups utilized by the U.S Census Bureau. Average household income is often used as a significant indicator of neighborhood income or community socio-economic levels. Neighborhood socio-economic characteristics are important indicators when studying the food environment, mainly due to the differential access to resources and limited availability of healthy food choices that lower income neighborhoods have vis-a-vis wealthier neighborhoods (Morland et al., 2002). The three neighborhoods - one high income, one medium income and one low income - were selected from the cities of Des Moines, West Des Moines and Altoona within the Des Moines Metropolitan area. Table 1 compares the different characteristics of the neighborhoods selected to participate in the study.
Table 1. Comparison of neighborhood characteristics

<table>
<thead>
<tr>
<th>City</th>
<th>Area (Sq. Miles)</th>
<th>Population</th>
<th>Median Household Income</th>
<th>Median Resident Age</th>
<th>Average Household Size</th>
<th>Estimated per capita Income</th>
<th>Median home value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altoona</td>
<td>7.1</td>
<td>13,854</td>
<td>50,162</td>
<td>32.2</td>
<td>n/a</td>
<td>25,528</td>
<td>178,043</td>
</tr>
<tr>
<td>Des Moines</td>
<td>77.25</td>
<td>197,052</td>
<td>43,583</td>
<td>33.8</td>
<td>1.5</td>
<td>24,466</td>
<td>119,700</td>
</tr>
<tr>
<td>West Des Moines</td>
<td>27.57</td>
<td>55,426</td>
<td>66,800</td>
<td>33.0</td>
<td>1.5</td>
<td>39,423</td>
<td>216,543</td>
</tr>
</tbody>
</table>

All data in the table is derived from U.S Census Bureau (2008) records

Selection of Participants for the study

Convenience sampling method was used to select a sample for this study. Colleagues who work for companies\(^1\) located within the neighborhoods identified in Des Moines, West Des Moines and Altoona were contacted and requested to take part in the pilot study. Contact was made first by phone, then followed up with an email that contained more details on the purpose of the study. Upon receiving a positive response, the contacts were then asked to invite and encourage other members of their departments to participate as well. A suitable participant for this pilot study needed to have the following characteristics:

- Over 18 years of age
- Reside within Polk County

\(^1\) The main attribute for identifying work sites or companies to participate in the pilot project was number of employees. We focused on work sites with 30 or more employees.
• Have a fixed day schedule\(^2\)

• Commute to and from work everyday\(^3\)

• Have easy access to computers and the internet

Table 2 shows a list of the companies that participated in the study and the number of participants from each company and Figure 1 shows a map of the locations of these companies as well as location of residences of individual participants\(^4\).

**Table 2: Employers Participating in Pilot Study**

<table>
<thead>
<tr>
<th>Employer</th>
<th>Location</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Financial</td>
<td>Downtown Des Moines</td>
<td>12</td>
</tr>
<tr>
<td>Community Housing and Development Corporation</td>
<td>Drake Neighborhood</td>
<td>3</td>
</tr>
<tr>
<td>Polk County Extension Services</td>
<td>Altoona</td>
<td>14</td>
</tr>
<tr>
<td>City of West Des Moines</td>
<td>West Des Moines</td>
<td>5</td>
</tr>
</tbody>
</table>

\(^2\) According to Presser (2003), in order to claim a fixed day time schedule, at least half the hours worked the prior week should be within the hours of 8 a.m. to 4 p.m. For this study, a fixed day time schedule referred to an 8 hour schedule between 8a.m. and 5p.m.

\(^3\) Commuting is regular travel between one's place of residence and place of work. Most commuters travel at approximately the same time day everyday

\(^4\) Some participants had their home residences outside Polk County. Data gathered from them on spatial access to food environment was excluded from the assessment done in this study. However, their responses on the effectiveness of the methodological tool to map the food environment were an important addition and were included in the results.
Participation in the study was completely voluntary. The names and email addresses of those who were interested in participating were forwarded to the researchers by the contact person from each company. The desired sample size was set at between 100 and 200 participants. The contacts at the work places forwarded a total of 90 people interested in participating in the pilot. Out of these, 34 ended up participating.
additional questions (see Appendix A for a copy of the Letter of Introduction).

The purpose of using a convenience or availability sampling method in this study was to increase the rate of participation for this pilot. In addition to the desired sample characteristics, such as the minimum age requirement and residence and workplace location, it was understood that there were other latent features within this population that were important considerations. Desired participants would typically be workers in fast-paced work environments, limited by busy work schedules and time constraints, and would generally have pressing work concerns to fit into their fixed day schedules. These features were potential barriers to participation and made this a difficult population to access. Using a convenience sampling method that utilized known contacts to recruit within their departments was perceived to be a good way to encourage participation in the pilot.

Data Collection

Using web-based surveys for visualization of workers’ transportation routes

Data collection in this pilot study was primarily done through the use of web-based surveys. Web-based, or internet surveys utilize the World Wide Web to contact participants, host the questionnaire or survey instrument and store the gathered data. This survey method was best suited in this case for a number of reasons: First, using the Internet to disseminate the surveys reduces the time and cost of conducting the pilot study. Secondly, using HTML forms streamlines the data collection process, improves formatting and enables users to enter responses directly into a database for analysis, which significantly reduces the possibility of errors in the data entering process found in most other forms of surveys. Thirdly, and most
importantly, web-based surveys are most naturally suited to accompany the development of digital mapping software for capturing workers travel routes being developed in this study.

Participants were asked to read and sign Informed Consent forms in accordance with Iowa State University’s Institutional Research Board regulations before they embarked on the survey (see Appendix A for a copy of the Informed Consent Form). After submitting these forms, the internet link to the website hosting the online survey was sent to their email addresses.

The survey used here was longitudinal in nature, requiring the respondents to complete daily questionnaires and map their home-work travel routes into a digital mapping tool over a 5 day period. It was divided into two parts. The first part, a one-time survey, covered questions that collected participants’ demographic data such as respondent’s age, gender, height, weight, household size and composition, household income, and mode of transportation to and from work. This initial survey also asked the respondent to recall their food purchasing behavior over the previous week and report on their frequency of visiting food outlets such as grocery stores, convenience stores, fast food restaurants and full service restaurants during that week.

The second part of the survey was to be filled out daily for the 5-day study duration. For this part of the survey, the respondents were given a set of instructions that would guide them through the process of mapping their travel routes and food outlet visits. First, each participant was asked to locate their home addresses on the map (their work-place addresses were pre-selected based on where each individual worked). Using a simple point-and-click method, participants were then asked to digitize (or draw) their daily home-work travel routes on the map by placing their cursor and clicking on the roads or highway networks they
used to get to work. They were also asked to indicate on the map any stops made along the way, especially those stops that involved purchasing food. An interactive text box was provided on the map, where respondents could enter information about the name of the food establishment visited, as well as the meal purchased (breakfast, lunch or supper). This information was compiled to determine patterns and food sources over the duration of the study and distance they have to travel to access food options. Figure 2.1 and 2.2 show the interface for the web-based survey:

Figure 2.1: First page of online survey used in the food environment study
Figure 2.2: Participant locating their home address on the map. The mapping tool automatically geocodes the address provided.

Along with mapping home-work travel routes over this 5-day period, participants also answered questions on distance traveled to get to retail food facilities and characteristics of their local food environment. Figures 3.1 and 3.2 show an example of an entry made by a participant into the online mapping tool.
Figure 3.1: Map showing route taken from home to work by participant

Figure 3.2: Map showing route taken from work to home by participant
Figure 4 shows an example of an entry made by a participant on stop to purchase lunch at a fast food restaurant. Participants could select the type of restaurant and insert the name in a text box. The software would then geocode the location of the restaurant or food outlet on the map.

Figure 4: Map showing stop made to purchase food at a fast food restaurant.
Institutional Review Board Requirements

This study complied with the Iowa State University Institutional Review Board requirements for conducting research on human subjects and was granted approval to conduct the research. Some of the main items that were considered in order to protect participants and do no harm included:

**Voluntary Participation**

All participation in this study was completely voluntary. Only adults over 18 years of age were allowed to volunteer. Although the researchers used contacts who were department heads within the companies, participants were under no pressure to participate as participation was in no way related to their work or performance. Also, no monetary rewards or incentives were given for participation, although participants could request the final results of the study to be sent to their email if they so wished.

**Informed Consent**

The informed consent process included supplying the participants with detailed consent forms that included descriptions of the study, its purpose and objectives, the voluntary nature of participation, duration of the study and the risks and benefits involved in taking part in the study. The participants were also informed that they could withdraw from the study at any time they chose. This form was available on the pilot website and was the first thing respondents saw as soon as they logged on. Participants were asked to sign the consent form only after they have
read and understood it and the Principal Investigator's (PI) contact information was made available for anyone with questions.

**Privacy and Confidentiality**

This study did not ask for any particularly sensitive or private information from any respondent. However, because respondents' names, addresses and contact information were included, as well as answers to questions that asked about household income, it was deemed necessary to store the data in a password-protected computer to which only the PI would have access to.

Participants were assured of complete confidentiality. Names and addresses would not be used except for tracking purposes and for sending the summary of the survey upon request of the participant. Participants names would also not be disclosed publicly for any purposes whatsoever and all results would be presented in aggregate.
CHAPTER 4.

DATA ANALYSIS AND REVIEW OF METHODOLOGICAL PROCESS

This chapter is divided into two main parts. In the first part, the results of analyses of empirical and secondary data gathered in this pilot study are presented. Using the data visualization and analysis tools in ArcGIS, data analysis is done based on two measures of spatial access: proximity - the distance traveled to food outlet, and density – the number of outlets per unit area. A discussion of the results will demonstrate how these two measures can be used to analyze workers’ interaction with the food environment along their daily travel routes. The second half evaluates the methodological approach used in this study, including a discussion of the strengths and weaknesses of the sample selection method, an in-depth analysis of the causes of attrition and an appraisal of the survey instrument and the advantages it offers as a tool for collecting spatial data to analyze the food environment.

Data Analysis

Foods purchased from full service and fast food restaurants have become an important part of the standard American diet. Reports show that in the last decade, consumption of out-of-home food has increased dramatically. People now eat out on average about 5 days a week, compared to 1-2 times in the 1960s (Prentice & Jebb, 2003). As food outlets continue to locate away from the urban core and concentrate at highway exits and along major transportation
routes, access to food outlet becomes an important consideration when investigating locational or spatial factors in the food environment. The spatial measures of access to food outlets and food service places used in this study will include proximity to food outlet and density of food outlets. The data collected is used to answer the following key questions: Is there an association between work travel distance and frequency of visits to grocery stores or the purchase of out-of-home food? Does the density of food outlets along one’s daily travel route influence where one stops to purchase food? Before discussing these questions, I will present the basic characteristics of participants in the pilot study as well as the variables used in the study.

Participant Characteristics

The total of 34 respondents participated in the Polk County Food Environment Pilot Study. Of these 34 participants, 14 worked for Polk County Extension Services located in Altoona, 12 for Principal Financial located in downtown Des Moines, 5 worked for the City of West Des Moines, and 3 participants from Community Housing and Development Corporation located in the Drake neighborhood of Des Moines.

Table 2 shows a summary of descriptive statistics for participants in the study. Approximately 77% of these respondents were female. Participant’s mean age was 36 years, with slightly more than one third of respondents being between 18 and 30 years of age. The next largest age group was participants between 50 and 60 years of age (29%), and the 40-50 age group had the smallest representation in this study (6%). About two thirds of the respondents

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Employees of Community Housing and Development Corporation were requested to test the survey instrument prior to the launch of the pilot study. It was determined after the study was designed that data collected from this organization would also be included in this analysis in order to increase the sample size.
were married and more than half of the respondents had children. Levels of physical activity among the respondents were high, with all but two engaging in some form of physical activity at least once a week. Of these, half engaged in physical activity at least three times or more a week.

Most respondents reported frequency of shopping at a grocery store at least once a week, with 42% saying they shopped at a grocery store two or more times in a week. 60% of the respondents reported frequency of purchasing out-of-home food at fast food outlets at between once and twice a week. The remaining respondents reported purchasing fast food three or more times a week, with 46% of these respondents reporting that they purchased fast food at least five times a week.

Based on self-reported personal income, the median income for the sample was $88,000 and mean income was $70,880, which is higher than the Polk County population median income of $54,268. Personal income of the participants ranged from $25,000 to $125,000.
Table 3. Participant Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of participants who responded</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>34</td>
<td>36</td>
<td>14.57</td>
</tr>
<tr>
<td>Male</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family size</td>
<td>34</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td>Frequency of Physical Activity per week(^7)</td>
<td>34</td>
<td>2.3</td>
<td>1.25</td>
</tr>
</tbody>
</table>

**Travel Mode**

<table>
<thead>
<tr>
<th>Travel Mode</th>
<th>Number of participants who responded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Vehicle</td>
<td>28</td>
</tr>
<tr>
<td>Carpool</td>
<td>5</td>
</tr>
<tr>
<td>Public Transportation</td>
<td>1</td>
</tr>
</tbody>
</table>

**Work travel**

<table>
<thead>
<tr>
<th>Work travel</th>
<th>Number of participants who responded</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance traveled</td>
<td>34</td>
<td>14 miles</td>
<td>10.69</td>
</tr>
<tr>
<td>Time spent on travel</td>
<td>34</td>
<td>24 minutes</td>
<td>12</td>
</tr>
</tbody>
</table>

To answer study questions, different types of geographic data were collected, including point data (geocoded locations of worksites, food outlets and participants homes), line data (disjunct lines – participant work travel routes, network – road and street network) and rasters (images or data structures made up of rectangular grid of pixels or points of color). Table 4 shows a breakdown of the independent and dependent variables used in this study:

\(^7\) Physical activity is defined as bodily movement produced by skeletal muscles that requires energy expenditure (WHO – http://www.who.int/topics/physical_activity/en/). Presence of facilities such as sidewalks and bike lanes, walking and biking trails as well as access to gyms and health clubs improve and rates of physical activity (McKinnon et al., 2009).
Table 4. Study Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement units</th>
<th>Geographic feature type</th>
<th>Attribute values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent Variables (x):</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant route</td>
<td></td>
<td>Disjunct lines (D)</td>
<td></td>
</tr>
<tr>
<td>Location of food outlet (geocoded x,y)</td>
<td></td>
<td>Point data (D)</td>
<td></td>
</tr>
<tr>
<td>Density of food outlets</td>
<td>Cell count</td>
<td>Continuous data [C]</td>
<td>Ratio data</td>
</tr>
<tr>
<td>Type of food outlet</td>
<td></td>
<td>Attribute data (D)</td>
<td>Categorical data</td>
</tr>
<tr>
<td>Work travel distance</td>
<td>Length in miles</td>
<td>Attribute data (D)</td>
<td>Interval data</td>
</tr>
<tr>
<td><strong>Dependant variable (y):</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of purchasing fast food</td>
<td>Count/Frequency</td>
<td>Attribute data (D)</td>
<td>Interval data</td>
</tr>
<tr>
<td>Frequency of grocery visits</td>
<td>Count/Frequency</td>
<td>Attribute data (D)</td>
<td>Interval data</td>
</tr>
</tbody>
</table>

Part of the secondary data in this study consisted of the locations of food outlets in Polk County. Business addresses for all Polk County food outlets and food service places were obtained from the Iowa Department of Inspections and Appeals, classified and tabulated. Adapting the Nutrition Environment Measurement Survey in Stores (NEMS-S) classification system for food stores and food service places developed by Glanz et al. (2007) and the North American Industry Classification System by the Department of Commerce (see Appendix A for NCAIS classes), the Polk county food establishments were classified into eleven classes.

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8 This study limited its scope to only three of the eleven classes – fast food restaurants, full service restaurants and grocery stores. These three are seen as major components of the food environment and are most frequently used by more people than the other classes.
Because a food outlet classification system like this one does not currently exist for Iowa food places, the food establishments were categorized based on name recognition (the Department of Inspections and Appeals assigns a broad category to the food outlets such as ‘school cafeteria’, ‘hotel’, ‘restaurant’ that were helpful in classifying particular food outlets), so for example, Guido’s Pizzeria was classified as ‘Fast Food Restaurant’ and Hyvee classified as ‘Grocery Store’. For this study, large supermarkets were not differentiated from smaller, corner groceries, and were classified together under ‘Grocery Store’. In the same way, fast-food franchise stores were not differentiated from other limited service restaurants and were all grouped as ‘Fast Food Restaurants’. A total of 1807 food outlets and food service places were classified into the 11 categories. Each food establishment was allocated to only one category. Table 5 shows the classes used for Polk County food outlets and the descriptions for each classification (following NEMS-S and NAICS classifications and descriptions) as well as the total count for each type.
Table 5. Classification of food outlets in Polk County

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Count</th>
<th>Included (I) or Excluded (E) from Pilot Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffee Shop</td>
<td>Snack and non-alcoholic beverage bars</td>
<td>56</td>
<td>E</td>
</tr>
<tr>
<td>Concession Stand</td>
<td>Mobile food services</td>
<td>53</td>
<td>E</td>
</tr>
<tr>
<td>Convenience Store/Mini Mart</td>
<td>Convenience food store (with or without gasoline stations)</td>
<td>127</td>
<td>E</td>
</tr>
<tr>
<td>Deli, Meat, Specialty Store</td>
<td>Delicatessens primarily retailing a range of grocery items and meats (except grocery store, restaurants)</td>
<td>26</td>
<td>E</td>
</tr>
<tr>
<td>Fast Food Restaurant</td>
<td>Limited service restaurants, carry out, drive-in and family restaurants</td>
<td>264</td>
<td>I</td>
</tr>
<tr>
<td>Full Service Restaurant</td>
<td>Family and fine dining restaurants</td>
<td>854</td>
<td>I</td>
</tr>
<tr>
<td>Grocery Store</td>
<td>Supermarkets and other grocery stores (except convenience)</td>
<td>116</td>
<td>I</td>
</tr>
<tr>
<td>Nutrition Program</td>
<td>Food programs catering to specific populations such as elderly or homeless</td>
<td>21</td>
<td>E</td>
</tr>
<tr>
<td>Other (Hotel Restaurant)</td>
<td>Food available at travel arrangement and reservation services</td>
<td>44</td>
<td>E</td>
</tr>
<tr>
<td>Other (School or Institution Cafeteria)</td>
<td>Cafeteria food service contractors at school, office, hospital or other institution</td>
<td>200</td>
<td>E</td>
</tr>
<tr>
<td>Seasonal</td>
<td>Stores open only during specific seasons of the year, particularly summer</td>
<td>46</td>
<td>E</td>
</tr>
</tbody>
</table>
Geocoding - the process of finding associated co-ordinates from other geographic data such as addresses - was done for each food establishment based on physical addresses (centerlines) and zipcodes. Food establishments that did not have an address, or only had a Post Office Box address attached to them were assigned one using the Yellow Pages and YellowBot online address and phone directories. 85% of the food establishments in the Polk County food establishment list were geocoded. We excluded all Nutrition Programs, School and Institutional Cafeterias, Hotel Restaurants and Seasonal outlets because they are not food establishments where people routinely get their food on an everyday basis. In addition, 37 duplicates and 40 food establishments whose addresses could not be found were also excluded, which resulted in 1496 establishments being used in the study. Figure 5 shows the geocoded food establishments overlaid on a map showing Polk County block groups by income.
Spatial Analysis Using ArcGIS Tools

The first step to analyzing accessibility to food outlets in our study area was to calculate the density of food outlets (number of outlets per unit area). Spatial analysis tools in ArcGIS...
were used to determine density of the three classes included in the study: fast-food and full-service restaurants for out-of-home foods and grocery stores for foods for home consumption. Kernel density analysis tool was used to calculate and identify the areas of high and low density for these outlets. Figures 6.1 and 6.2 below show the kernel density layers for fast food and grocery stores for the Polk County area.

Figure 6.1: Map showing density calculations for out-of-home food outlets and food service areas (full service restaurants and fast food restaurants) in Polk County, IA. Insert shows areas of highest density.
Figure 6.2: Map showing density calculation for for-home food outlets (grocery stores and supermarkets) in Polk County, IA. Insert shows the areas of highest density.

Reclassification

Using spatial analyst tools, it was important to reclassify the data to enable cell-based analysis in like units. Therefore for all layers – income, fast food (all out-of-home food including full service restaurants) and grocery – 2 steps of reclassification were completed to give change the cell values from decimal values to integers. Figure 7 shows the reclassification process for each layer, where each decimal range is given assigned a nominal value. Income was assigned
values from 100 to 600, fast food raster layer assigned values from 1 to 8 and grocery store raster layer assigned values from 10 to 80. Using Map Algebra (Addition function), the reclassified data was overlaid to form a new continuous layer.

![Figure 7: Reclassification of cells in income, fast food density and grocery density layers](image)

To identify areas of high density for either fast food stores or grocery stores in Polk County, the new layers resulting from the Map Algebra Addition process were assigned values that would determine whether it is a high, medium or low food outlet density area, based on the concentration of outlets within that location. For example, a value of 100 on the income raster overlaid with a value of 8 in the fast food raster was determined to be an area of low income with high fast food density. Likewise, a cell value of 500 in the income layer that corresponds with a value of 80 in the Grocery Store layer was an area of high income with high grocery store...
density. Tables 6a and 6b show an illustration of this process for both fast food outlets and grocery stores:

**Table 6a: Assigning nominal values to cells in Fast Food layer**

<table>
<thead>
<tr>
<th>Income</th>
<th>Fast Food</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 (low income)</td>
<td>8 (high fast food density)</td>
<td>108 (low income area with high fast food density)</td>
</tr>
<tr>
<td>300 (medium income)</td>
<td>3 (low fast food density)</td>
<td>303 (medium income with low fast food density)</td>
</tr>
<tr>
<td>600 (high income)</td>
<td>10 (high fast food density)</td>
<td>610 (high income area with high fast food density)</td>
</tr>
</tbody>
</table>

**Table 6b: Assigning nominal values to cells in Grocery Store layer**

<table>
<thead>
<tr>
<th>Income</th>
<th>Grocery</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 (low income)</td>
<td>30 (low grocery store density)</td>
<td>130 (low income area with low grocery store density)</td>
</tr>
<tr>
<td>200 (medium income)</td>
<td>90 (high grocery store density)</td>
<td>290 (medium income with high grocery store density)</td>
</tr>
<tr>
<td>500 (high income)</td>
<td>80 (high grocery store density)</td>
<td>580 (high income area with high grocery store density)</td>
</tr>
</tbody>
</table>

Figures 8.1 and 8.2 show the areas that were identified as areas of interest for the study in Polk County. Employers who participated in the pilot project came from at least one of the areas highlighted on the map. For example, Principle Financial and Commercial Housing as located in an area of low income, high density fast food, high density grocery and while City of West Des Moines was located in an low density fast food, low density grocery and high income.
Figure 8.1: Areas in Polk County with very high or very low Fast Food Density

Figure 8.2: Areas in Polk County with very high or very low Grocery Store Density
Data gathered by the surveys was compiled using MySQL. MySQL is a relational database management system that is used to query a number of databases. To covert the MySQL data, a PHP script (Hypertext Preprocessor – scripting/programming language for web development) was written that converted the MySQL data for the routes and stops to KML formatted text. Keyhole Markup Language (KML) is a file format for displaying geographic data in a two, or three dimensional map browser such as Google Earth or Google Maps. Global Mapper was then used to convert from KML to polyline shapefile. The demographic data was saved from MySQL to an Excel file and then loaded into ArcMap as a table. The Lat/Long was then plotted as X/Y points (Seeger, 2008).

Figure 9: Converting geospatial input to GIS format
Figure 10 below shows all the gathered data on participant’s travel routes from home to work, work to home, and stops made for food purchase:

Kernel density layers were calculated to determine the density of Polk County food outlets and food service places and then overlaid with the data on individual travel routes and stops made to purchase food provided by study participants. Multiple line buffers were created around each participant’s work travel routes at 1 mile and 2 miles and all food outlets
that were within this distance were selected by location. The 1 and 2 mile buffers are based on the expectation that at these distances, participants have easy access to food stores and food service places either by foot or by motorized transport (Jeffrey et al., 2006).

Figure 11 shows a map of work travel routes for 3 participants in the study buffered at 1 and 2 miles, overlaid with food outlet density layer and indicating locations where participants stopped to purchase food:

Figure 11: Buffered work travel route with food outlets density layer and stops made by 3 participants
Measuring Access to Food Outlets along Transportation Routes

The importance of looking at locational/spatial factors in the study of the food environment is that it improves the operationability or measurability of the food environment. Locational factors such as proximity, distance and density lend themselves easier for measurement than other attributes such as individual perceptions, motivations, attitudes and beliefs concerning nutrition and health behavior. Many previous studies on the food environment have investigated accessibility to food outlets and the availability of healthy foods within a community, in mostly residential neighborhoods. This study looks at access to food outlets along daily transit routes for commuting workers, providing a much needed additional dimension to food environment studies.

i) Proximity

Proximity involves the measurement of the nearest distance to food stores or food service places. Distance to the food store may be measured by shortest path Euclidean distance (“as the crow flies”) or Manhattan distance (by city block or street) (Apparicio et al., 2007). In this study, 1 and 2 mile buffers were set around each participant’s work travel routes to specify the distance within which food outlets were considered easily accessible. Because the data on each participants daily travel routes from home to work and back was available, Manhattan distance method was used to measure travel distance between home and workplace, while Euclidean distance was used for the 2-mile buffers.

One of the questions under investigation in this study was whether commuters with longer travel distances are more likely to purchase out-of-home food. Since individual travel
distances varied greatly, participants’ travel distances were classified into 3 groups as shown in Table 7: Group 1 - Short travel distance of between 0-10 miles; Group 2 - Intermediate travel distance from 11-20 miles; Group 3 - Long travel distances of 21 miles and over.

Table 7. Group classifications

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
<th>Distance (miles)</th>
<th>Number of Participants</th>
<th>Frequency of eating out (avg)</th>
<th>Frequency of grocery visits (avg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Short travel</td>
<td>0 - 10</td>
<td>9</td>
<td>1.7</td>
<td>1.3</td>
</tr>
<tr>
<td>2</td>
<td>Intermediate</td>
<td>11 - 20</td>
<td>13</td>
<td>2.2</td>
<td>1.4</td>
</tr>
<tr>
<td>3</td>
<td>Long travel</td>
<td>21 and over</td>
<td>7</td>
<td>4.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

*Kendall R* test, the non-parametric equivalent of *Pearson’s R* test, was run to calculate the correlation coefficient at a 95% level of significance, for the relationship between distance and grocery visits as well as for distance and number of times participant purchases out-of-home food (see Appendix B for ANOVA test results).

Results of the analysis of the relationship between work travel distance and number of grocery visits, as well as work travel distance and out-of-home visits is shown in Table 8. An ANOVA test calculates the strength of the association between variables (variable x is insignificant in predicting variable y when p is greater than 0.10, mildly significant if 0.05 < p < 0.10, and significant if p is less than 0.05 at a 95% level of confidence).
The results reveal that work travel distance and number of grocery visits are positively correlated at a 95% confidence interval, meaning as distance increased the number of grocery visits also increased. However, this relationship was only true for 12% of the cases in this study ($r^2 = 0.119$).

An observed trend in the data indicated that participants with intermediate and long travel distances (Groups 2 and 3, respectively), tended to purchase out-of-home food more frequently than those with short travel distances. However, when this observation was submitted to the Kendall $R$ test, the results showed that participant’s travel distance had no significant effect on the frequency of purchasing out-of-home food at fast food or full service restaurants for any of the three groups (see table 8). This contradiction in the observed and tested results may be explained by the small size of the sample and the fact that the distribution was not normal.

<table>
<thead>
<tr>
<th>Independent Variable (y)</th>
<th>Dependent variable (x)</th>
<th>N</th>
<th>Correlation coefficient ($r$)</th>
<th>$r^2$</th>
<th>p value</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work travel distance</td>
<td>Number of grocery visits</td>
<td>25</td>
<td>0.34526</td>
<td>0.119</td>
<td>0.0529</td>
<td>$y = 1.218 + 0.035x$</td>
</tr>
<tr>
<td>Work travel distance</td>
<td>Frequency of purchasing out-of-home food</td>
<td>29</td>
<td>0.08725</td>
<td>0.0076</td>
<td>0.6237</td>
<td>$y = 2.237 + 0.012x$</td>
</tr>
</tbody>
</table>

Participants were also asked whether the distance they needed to travel from their regular route to the nearest food outlet was a major determining factor for the food outlet they chose. For those who answered that question, distance traveled to get to the food outlet was not a major consideration. 24% of the participants stated that the location of the outlet
was convenient while 28% said it was very convenient for them. A further analysis of the data revealed that 69% of the participants stopped to purchase food within 1 mile of their daily transportation corridor.

Although participants did not perceive distance to be a hindrance to their ability to purchase food, previous studies show that the distance an individual has to travel to purchase food can be a major factor in their ability to access healthy food (Swinburg, et al., 1999; Seth & Randall, 2001). In auto dependent environments, location may not be perceived to be a hindrance to access especially for middle and higher income individuals (Frumkin et al., 2003). However, when an outside stressor is applied, such as high gas prices or lack of personal auto and transportation mode choice, the location of a facility and the distance travelled to reach it becomes a major factor in one’s decision-making process. In this study, 82% of the participants drove personal autos and 15% carpooled to work. During the time of the study (November 7th-14th, 2008), gas prices may not have been a very big concern for participants. The average gas prices in the Greater Des Moines area at the time was $1.80/gallon, which was a 52% reduction in gas prices from the highest point in the summer of 2008. Additionally, the cold weather and climatic factors at the time may have encouraged participants to drive or ride the bus, instead of walking or biking, which reduced the limitations to access that are associated with lack of motorized transportation.

ii) Density

To answer the question of whether participants tended to stop at points of higher store density or high concentration of food outlets along their work travel routes, density of food
stores was grouped into three levels: level 1 for low density, level 2 for medium density and level 3 for high density. A weights matrix was used to assign weight to stops (see table 9). The stops made at points of high density were given more weight than stops made at points of low density. This was done to test the assumption that people tend to visit stores that are located in points of high density more often than those that are located in points of low density. *Kruskal-Wallis* rank sum test was then performed on the data (see appendix B).

<table>
<thead>
<tr>
<th>Level</th>
<th>Food outlet density level</th>
<th>Number of stops</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Low density</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>Medium density</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>High density</td>
<td>6</td>
</tr>
</tbody>
</table>

An analysis of the food store density levels where participants tended to stop to purchase food on their daily work travel routes showed that while more participants stopped at points of low density than at high density food outlet areas, the frequency of stops at points of low density was fewer than that of high density. That is to say, although many participants stopped at low food outlet density areas, they each recorded only one stop over the five days. On the other hand, participants who stopped in high density food outlet areas recorded multiple stops (about 3 to 5 times) over the 5 day period. This result can be explained by participants combining several trips into one, for example, stopping at a grocery store as well
as picking up some food at a fast food outlet at a highway commercial shopping center. Figure 12 shows a graphical representation of these results.

![Graph of food density versus frequency of stops at each outlet density level](image)

**Figure 12: Graph of food density versus frequency of stops at each outlet density level**

In Polk County, the density of grocery stores and supermarkets as well as full-service and fast food restaurants seemed to be higher in low income block groups in than in high income block groups after controlling for population. Although this is contrary to other studies on neighborhood socio-economic status and availability of food stores (Morland et al., 2002; Maddock, 2004; Glanz et al., 2005; Apparicio et al., 2007), this is not surprising for Polk County. The drastic reorganization of retail food stores nationally in the 1980s and
1990s that left many central cities with a gap in retail food provision to the mostly lower income central city residents did not affect the Greater Des Moines area at the same level as other cities across the country. A reduction in population and economic growth in the 1980s and early 1990s meant that few people left the older, more established parts of Greater Des Moines for the suburbs (Grey, et al. 2003). As such, many of the retail food providers stayed in their original locations instead of leaving for the empty lots in the edges of the city.

Additionally, a growing number of African-American, Latin American and African migrants into the Polk County area have created a growing demand for discount food stores that offer healthy food products at affordable prices for these populations (Grey, et al. 2003). Our classification of food establishments revealed an extensive network of small grocery stores available within short distances of ethnic neighborhoods, providing a tremendous opportunity for creating healthful food environments within these neighborhoods. Two of the lowest income block groups in Polk County have the highest density of grocery stores due to this factor. This network of small ethnic grocery stores has become an efficient strategy of ensuring the availability of healthy foods to the lower income neighborhoods (Raja et al., 2008).

Apart from neighborhood socio-economic status, racial disparities in the food retail environment have also been previously documented as having a mitigating impact on food availability and access (Zenk et al., 2005; Morland et al., 2002). According to the literature, neighborhoods of predominantly minority populations have fewer grocery stores and supermarkets and were located on average 1.15 miles farther away than in predominantly Caucasian neighborhoods (Zenk et al., 2005). In Polk County, race and ethnicity did not
seem to be a factor. Polk County is predominantly Caucasian (92% of the population) with a small percentage of non-Caucasian races (U.S Census, 2007). Even in neighborhoods with a larger non-white population such as in the central and southern parts of the county, there was no noticeable lack of healthy food outlets. Density of fast-food and other outlets was not found to be associated with area deprivation nor were density measures associated with area-based measures of wealth and racially based residential segregation.

Review of Methodological Process

This study tested a new f-VGI methodology to gather first-hand user-generated information on the food environment. This section evaluates this method’s effectiveness as a data collection tool. It includes a review of the sample selection method, causes of attrition in the study, and analysis of the feedback from the participants on their experiences with the tool. This section will also propose ways to reduce respondent drop-out rates and make recommendations on ways to improve the web-based survey so as to boost the effectiveness of this methodology.

i) Bias in Sample Selection

As indicated earlier, the sample for this study was selected through known contacts from different organizations in Polk County, who in turn recruited participants from within their departments. Although this convenience sampling method helped increase the
participation rate, it resulted in a restricted, non-random sample and may have introduced possible bias in the sample.

A study by Cook et al., (2000) on factors that influence response rates to internet-based surveys found that person-to-person contact with participants, contacting sampled people prior to sending out the survey and making follow-up contact with non-respondents were the three dominant factors in attaining higher response rates in internet-based surveys. For this study, personal visits to potential participants were made before the beginning of the pilot for two of the work sites (Polk County Extension Services and Community Housing and Development Corporation). These visits made for the purpose of providing background information on the pilot study and to answer any questions or concerns they had before they embarked on the surveys proved to be very helpful in opening up communication lines and maintaining close contact with respondents.

Convenience sampling is best suited for this study for two main reasons. First, because this pilot study was testing a new methodology, it was important to select participants who displayed a level of commitment to beginning and completing the study. Selecting an unknown random sample that did not have any background information on the study would increase chances of non-response, especially because the survey had a mapping component and many would shy away from the potential difficulty of the mapping experience. Secondly, having a pool of participants that knew either the contact people or the researchers directly made communication between researchers and participants much easier. Any difficulties, questions or problems encountered when answering the survey questions or using the methodological tool could be easily and promptly communicated and resolved.
However, it is important not to overgeneralize the results from this study because the sample was not representative of the population, and was too small. So as not to face selection bias in a future study, a randomly selected sample would be best to ensure that all members of the population have an equal chance of being selected, and that the results can be generalized to the larger population. Increasing the sample size would also increase the robustness and generalizability of the results.

**ii) Attrition**

This pilot study was designed to be a mini-longitudinal study to be conducted over a 5-day period, where participants were asked to record their interaction with the food environment along daily travel routes. The advantage of using a longitudinal study over a one-time cross-sectional snapshot, is that it enables researchers to trace dynamics of behavior by identifying the influence of past or repeated behavior on current behavior. Longitudinal studies increase the understanding of the effect of time-varying exogenous variables on perceived behavior (Alderman et al., 2000). However, one of the major issues with longitudinal studies is sample attrition, where study participants are lost or do not complete the full length of the study for a number of reasons. High attrition rates make interpretation of estimates problematic and cause bias in the ensuing results. Researchers have to grapple with how to retain participants and avoid non-responsiveness and attrition at the study design stage and through the length of the study.

For this study, in order to keep participants interested in the study and maintain their participation over the 5-day work week, reminder emails were sent out every morning, with
instructions on how to log into the survey website and where to find step-by-step instructions on how to input their previous day travel route from home to work and back, and any stops made to purchase food over the course of the previous day. However, this was not entirely effective because many participants either did not read those emails or due to pressure of work decided not to participate on certain days of the study. Tables 10 shows a breakdown of participant numbers during the course of the study.

Table 10: Participant totals during the course of the study

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people contacted</td>
<td>90</td>
</tr>
<tr>
<td>Number of people who started survey</td>
<td>34</td>
</tr>
<tr>
<td>Number of people who stopped before the end of the survey</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
<th>Number of people who dropped out</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Number of people who completed full study | 28

Web surveys are quite unlike other survey methods of data collection, in that they are usually self-administered surveys, with the respondent having almost complete control over the process once they receive the survey. The respondent generally determines when to answer questions, which questions will be answered and how long it will take. Also, they require a certain amount of technical know-how, at least up to the level of knowing how to
use a computer and to navigate a web-browser, which can also affect the quality of response if the web-survey has too many complicated graphics or links. These factors can pose significant difficulties, far removed from the ease of responding to mail or telephone surveys, and can lead to an increase in the rates of participant non-response or attrition.

A study conducted by Jeavons (1998) investigating the trends or behaviors of respondents who dropped out of three major studies discovered the types of difficulties that lead to an high counts of non-answered questions, or repeated answer attempts. Using an analysis of detailed server logs from these three web surveys, Jeavons was also able to determine the causes of non-response or lack of interest leading to attrition. He found that a relatively high percentage of potential respondents stopped completing the surveys at three main points: First, when encountering the first question, he noticed that respondents who were confused about the nature of the response required either immediately refused to proceed or made many repeated attempts to answer the question. Secondly, when encountering a complex question grid, many respondents did not respond to it and moved on to another, or dropped out of the survey at that point. Lastly, when asked to supply their email address, many respondents were reluctant to supply any form of personal information and would usually drop out at this point.

Using this insight into causes of participant non-responsiveness, researchers in this project reflected on the rate of attrition in the Polk County pilot study, and raised several questions that would help them pinpoint the problems that would have caused participants to drop out. Several factors that are believed to have an effect on attrition rates were identified,
including the survey and website design, instructions on using the mapping tool, user mapping skills and technical difficulties. These factors are discussed below.

a) Survey and website design

The design of a survey can affect the response rate, the dropout rate, and even the responses themselves. Couper et al. (2001) studied the differences in response rate and responses using scrollable web surveys that display all the survey questions on the same page, versus interactive web surveys that display one question at a time on the screen. They found that if they altered the presentation of the one-question screen to allow multiple questions to appear at the same time, completion time for the survey was faster, there were fewer non-answered questions, and there was more similarity in answers than when questions were presented individually. When they tested the response rate of the same survey questions with radio boxes and entry check boxes, they had mixed results depending on the type of question asked. Some of their questions required addition or elaboration, and found that the radio box version, with its dense screen layout and its horizontal format, required more eye-hand coordination and bring more response errors or greater non-response than the vertical format (Gunn, n.d).

The survey used in this study utilized a mixed radio button and text box design with a vertical format that allowed users to either select an option or enter a detailed response wherever applicable (see Appendix A for copies of the surveys). During the course of five days, several calls and emails sent to the researchers alerted them to the problems faced by respondents as they went through the surveys. Follow-up questions to participants to
determine the cause of the problems revealed that there weren’t any perceived problems with
the survey website design, as it was graphically simple and clear. The same case applied for
the design of the first survey (the demographic survey), as it was a standard HTML
(HyperText Markup Language) form that was easily recognizable and easy to fill. Multiple
questions appearing on the same screen enabled participants to work through them relatively
quickly and piqued their interest about the set of surveys that would be administered over
five next days.

b) User mapping skills and difficulties with using the mapping tool

The most difficulties were experienced when participants began working on the 5-day
survey. Several participants had trouble with the mapping tool, especially when drawing or
digitizing the travel routes. Other participants had difficulty with the instructions on how to
navigate within the map interface or how to make changes when they had made an error or
wanted to alter some information. Participants also had difficulties interpreting what some of
the questions were asking.

It was important to respond the concerns raised by the participants as soon as they
raised them. The responses were sent directly to the participant who raised the issue, under
the assumption that not everyone may be having that same problem and therefore it was
unnecessary to bombard all participants with constant emails. Although this helped to reduce
information overload for the participants, it may have caused those who had the same
problem but did not speak up to miss out on information that would have made the survey
experience much easier for them. Comments gathered from the satisfaction survey
administered at the end of the 5-day study period showed that some issues needed to be addressed to make the experience smoother for participants.

For example, on the subject of understanding the questions and instructions, one participant commented:

“A few of the questions I had to read twice to understand -- like if I stopped for food after I arrived home, then not to put it on the map.”

One way to resolve this issue and to ensure that future studies design questions that are easy to comprehend, and have clear, concise instructions, would be to develop brief, easy-to-read, questions with easily noticeable instructions to accompany each question in the 5 day survey. Instructions can be inserted in a different font and size that would capture the attention of the respondent.

For many participants, the main problem was associated with digitizing the routes, and making them align with the streets on the Google Maps interface. This difficulty had been noted at the beginning of the study, and it was expected that participants who are generally not comfortable with mapping or are untrained in geographic sciences may find this exercise difficult and may be apprehensive about doing the mapping. Comments from participants outlined the types of problems they encountered:

“Also - very important note - when placing the markers on the map about where I stopped for food or dropping off my child, it was very difficult to get the marker to pop up until I realized, you have to click in the space where a house or business would be, NOT on the road path I had just drawn that my car travelled.”
“Clarify that you need to click along your route to drop markers instead of just clicking and dragging the marker along your route till you get to your destination. Also, need to be able to back track through the questions/mapping to erase a dot or two rather than having to erase the entire mapping to re-do.”

“It took me multiple times to figure out how to use it, but I finally figured it out why the lines didn’t go where I wanted them to go”

“I was unclear just how exact the mapping needed to be. I travel around 100 miles/day and it takes quite a while to map every little curve in the road.”

One way to tackle this issue would be to provide a brief training video on how to use, draw and edit routes that would supplement the written instructions. This video would show how to perform different functions on the map such as how to digitize routes so that they align with the streets, or how to place markers where stops for food were made. This would be of great benefit to those participants who do not feel free to ask questions or to present the difficulties they are encountering. Also, including a few introductory statements that address assumptions that people may have about mapping would help to dispel the apprehension that some participants have about the mapping component of the survey. Once the respondents find out that the mapping required is not as difficult as it sounds, they would more relaxed and look forward to answering the daily survey. Some comments from participants after they had received answers to their questions regarding mapping their routes illustrate this point:

“At first I was afraid it was going to be too difficult, but it really wasn’t.”

“Once I got the hang of the mapping tool it was easy to use.”

“It was a unique experience and kind of fun!”
“Very simple to use the mapping tool provided in the survey”

“I really enjoyed participating in the survey and don’t have any recommendations for improvement. I found it very easy to use!”

Another issue that came to the fore was participants had difficulty with defining the concepts, given the different scenarios they would find themselves in during their workday. For example, because home-to-work travel sometimes involved making work-related detours en-route to the work place, it was not always easy for participants to determine which part consisted of their home-to-work route and should be mapped, and which should not. The same problem arose when participants shopped for work-related food and did some personal food shopping as well. The following comments from participants who encountered these problems illustrate this:

“One of the other minor problems is if we are going straight to the office or heading to a meeting or other errands first. Or if we are going home from a meeting or program that was not at the office.”

“The challenge with some of the questions is that on perfect days I drive to work, take a quick grocery run/fast food break, and drive straight home. I rarely have a perfect day.”

“During the day I visit Des Moines schools to do programs. I will be shopping for food to use with these programs. Sometimes I pick up some things for myself at those stops, sometimes I don’t. Do you want all of these grocery store stops included in this survey or just ones that include personal purchases?”
To make understanding the concepts used in the study much easier, one recommendation would be to create a Frequently Asked Questions (FAQ) list for users that includes definitions of the commonly used concepts in the study such as ‘work route’, ‘food outlet’ or ‘stop for food’. The FAQ should also illustrate different scenarios which do not apply to the study, or that would not meet the definition of the concepts as used in the study.

c) Length of the Study

Longitudinal studies offer the advantage of identifying factors that influence behavior by providing a way to study time-varying variables. However, despite this advantage, it is important to evaluate the gains of a longitudinal study in light of its losses. The length of time that a respondent is required to commit to the study is one of the biggest deterrents to participation in long-term studies. In this pilot study, it was important to evaluate the quality of the data collected over the length of the study against the need to retain the interest of the participants. One such consideration was to assure the participants that the amount of time it would take out of their busy work day to fill out the surveys daily was minimal. A test run of the survey showed that each day would require a time commitment of about 5-7 minutes for the respondent to fill out the survey and digitize in their travel routes and indicate where they made stops for food purchase, without foregoing important details and lowering the quality of the information.

While it is important to come up with ways to retain participants through the entire course of a longitudinal study, these studies need to be long enough to capture the variation in behavior caused by time in order to achieve their purpose. Although it is a delicate
balancing act between participation and data quality, it is a critical not to tradeoff data quality for participation. Starting off with a large sample size would help to reduce biases in data caused by participant loss, and relieve the pressure of maintaining a sample large enough to provide robust data (Alderman et al., 2000). In this pilot study, 5 days was sufficient to begin to identify the trends in commuting workers’ interaction with the food environment along their travel routes, but was not long enough to make definite claims based on the data gathered. For future research, a longer period of two to three weeks would be better suited to answer the study questions.

It is also important to note if there is selective attrition in the study, that is, whether more participants with particular traits will drop out of the study than those without those traits. As the sample size in this pilot study was too small to make definite conclusions on the characteristics of those respondents who dropped out of the study, it is interesting to note that age seemed to be a selective factor for completion. All participants within the 18-30 age group who started the survey also completed it on the 5th day, while only 66% of 30-40 age group and 88% of 40-50 age group completed the study. Based on the comments given in the satisfaction survey, those within the 18-30 age group encountered the most problems with instructions and using the mapping tool. In spite of this, most said they enjoyed the experience and all completed the survey. The age group with the least difficulty with the instructions and using the mapping tool was 40-50 age group.

iii) Challenges in using a web-based participatory methodology
Accurate measurement is a cornerstone of science, with improvements in knowledge intricately dependent on solid instrumentation that is reliable (consistent and repeatable); valid (measuring what it purports to measure); and sensitive to meaningful change. Emerging research areas, such as the study of environmental influence on nutrition, present an opportunity to develop theoretical or conceptual models underlying measurement and instrumentation that can capture these complicated constructs (Saelens et al., 2009).

Web-based survey methodologies offer numerous advantages to research studies, such as time expediency in administering the survey, reduced cost and the ability to enter data dynamically. Still, there are several challenges that arise from selecting the web as a medium for disseminating a survey, that can in turn pose as challenges to consistency and repeatability of the study, as well as raise questions on validity and reliability of the data collected.

Currently the biggest concern to this study is coverage bias or bias due to sampled people not having access to, or choosing not to access, the Internet. Because the internet can only be accessed through computers and digital hand held devices, it immediately locks out those without access to these devices from responding (Kay & Johnson, 1999; Crawford, Couper & Lamias, 2001). While this may not be a very big problem for the workers who participated in this study, it is a major stumbling block in places where having a computer is still considered a luxury, and having the resources to use it is rare, especially access among lower socioeconomic groups (Solomon, 2001).

Respondents may also have different levels of computer expertise. In specific populations where internet access is extremely high and coverage bias is likely to be less of a
concern such as among college students and university faculty, experience and comfort with internet-based tools such as web browsers may be a concern that would need to be addressed, to avoid low response rates (Solomon, 2001).

The use of web-based forms for surveying poses a unique set of issues and challenges that need to be addressed to ensure valid data. The Web is a very public place and unless steps are taken to limit access to a survey, it may be found and responded to by people who are not among those sampled by the researcher (Couper & Lamias, 2001; Solomon, 2001). This can either happen by accident or maliciously. Since one only has to ‘point and click’ on the "submit" button to respond to a Web-based survey instrument once it is filled out, it is also quite possible for respondents to either mistakenly or purposefully submit multiple copies of their responses.

In the administration of the survey used in this study, only those participants who supplied their email addresses were given access to the survey website, in order to limit access to the survey by the public. Combining an email cover letter as a means of contacting sampled people with the use of a web form for data collection provides an especially effective and efficient approach to Internet surveying (Gunn, n.d.; Solomon, 2001). Modern email packages automatically convert universal resource locators (URLs) or web-addresses in the text of an email into a hyperlinks. Placing the URL of the survey form in a cover letter email allows the respondent to "click" their mouse on the URL to display the survey form and subsequently fill it out.

Information supplied on the internet can provide more details than a respondent intended. For instance, using cgi scripts, Java applets and user computer log files, a surveyor
can gather metadata about participants and be able to determine the time of day the survey was completed, how long the respondent took to complete each question, the length of time it took the respondent to complete the entire survey, what browser was used, and the respondent's IP address (Bosnjak & Tuten, 2001). Although this information is of great benefit to the surveyor and can supply information that could be used to improve the survey design and construction, it is many times collected without respondents’ knowledge or permission, causing a concern with the privacy of the data entered on a web survey. Thus, while privacy issues may become a concern to the respondent, it is, in such as case, a benefit to the researcher.

Problems associated with the computer programming codes used to create the questionnaire can also be a source of error with web-based surveys. In this study, some technical issues that needed to be promptly addressed came up during the course of the survey. One such issue was that users would forget which email address they had initially registered and would use a different one to log into the survey website with on a different day. Although the study instructions requested participants use only their work email, this was not always the case. The solution for such occurrences in the future would be to give each user a unique login I.D. that they would use instead of their email address.

Despite the difficulties that may exist in the use of Volunteered Geographic Information, it is fast becoming one of the cheapest sources of geographic information. The most important value of VGI is that it is created by ordinary citizens who provide views rich in local knowledge that ‘experts’ in government organizations, university researchers, or large research corporations may not have access to. Since VGI is many times asserted or
provided by its creator without citation or reference, citizens become peer reviewers and censors, correcting and clarifying the information provided, and becoming leaders in the creation and dissemination of valuable geographic information that can be central and vital to the development of new research areas such as food environment research.
CHAPTER 5

SUMMARY AND CONCLUSION

The fundamental goal of food environment research is to identify characteristics of the environment that affect health outcomes and determine which components can be easily altered so as to induce behavior change and improve health (Oakes et al., 2009). The need to bridge the gap between research and practice to reduce or eliminate disparities in health among urban populations calls for the development of tools that include the public in the production and interpretation of knowledge and data (Forester, 1999).

The expansion and advancement of computer tools over the last few years has greatly increased accessibility to, and ease-of-use of, software for design and analysis, not only for technicians and academicians, but also for grass-root community groups, Community-Based Organizations and other stakeholders across different landscapes. Over the last 40 years, researchers have been able to adapt digital participatory technologies to reach communities and participants that have been previously unreached. By using tools and technologies such as Geographic Information Systems (GIS), researchers are able to include ‘space’ as a study variable, placing factors into their spatial context to develop more robust analysis and results.

As a profession, planning has the interdisciplinary skills to understand systemic connections in the food environment, as well as the ability to facilitate changes in
communities through design and planning interventions that lessen food insecurity in urban neighborhoods. Planners should resume their role of acting as advisors to communities on how to use physical and environmental resources to meet the needs of all the members of society. According to Malizia (2006), planners have an important role to play in encouraging healthy life styles by encouraging the cities and counties to adopt strategies that foster healthier populations. Identifying public health and safety as primary goals would also give planners more tangible and profound criteria to evaluate public policies, plans, and projects. Such strategies can include: increasing grocery retail in underserved areas by conducting systematic citywide and neighborhood-level assessments of food demand; identifying and supporting the creation of area-wide programs that attract and retain healthy food options such as grocery stores and supermarkets; and developing a view of the food environment as an important contributor to neighborhood quality of life rather than a suboptimal economic development tool.

Transportation and Food: Focusing on Access

Millions of Americans, especially those with low socio-economic status and transit-dependent populations, have trouble accessing healthy foods (Vallianatos et al., 2002). While some work has been done on food availability in residential areas and work place neighborhoods, there is still a vacuum in studies that look at the food environment along transport routes. Additionally, more work is required in the development of programs that
improve access to food shopping centers for private commuters, public transit users, walkers and cyclists are still at a minimum.

The opportunity to establish a food and transportation link with the aim of increasing access is available through the reassessment of transportation policy. By encouraging policy-makers to go beyond the current narrow focus on highway infrastructure and efficiency to a multi-dimensional emphasis that includes access and social equity, transportation and land use policies attuned to the nation’s food security needs can build bridges between farmers, food retailers, and consumers. Transportation policies and programs can make it easier for low-income families, the aged, and others with mobility challenges and particular nutrition needs to access supermarkets, farmers’ markets, and other sources of affordable, healthy food. Innovative policies can also help small farmers transport their products to markets and meet untapped demand for local, fresh food (Born et al., 2005; Vallianatos et al., 2002). These links can help revitalize urban neighborhoods and improve the health and wellbeing of community members.

Developing transportation policies that focus on critical community and household food needs would minimize barriers to access and make it easier for commuters, both for those using public transit as well as personal auto, cyclists and pedestrians. Some suggestions for increasing food access along transportation networks that planners can adapt include:

- Coordinate economic development efforts and transportation and land use policies to locate new food and farmers’ markets at transit hubs. Commuters tend to rely on the services easily available to them along transportation routes. The need for well-planned transport corridors, that offer services that
are not only essential, but also foster healthy practices, should be a top consideration in transportation planning.

- Ensure existing and new transit systems provide direct connections between low-income and transit-dependent communities and food retail locations. Some communities across the U.S have already done this. For instance, in Hartford, Connecticut, the L-Tower bus route was redesigned to link transit-dependant commuters in the northern areas with major supermarkets and food shopping areas. The benefits were tremendous for both commuters and the bus company. Ridership increased by 230% in 11 months, with 33% of riders citing grocery shopping as the main reason they took the bus (Vallianatos et al., 2002)

- Fund transportation programs to increase access to fresh produce and healthy food for seniors, schools, child-care centers, and after-school programs. For example, by providing incentives for food and farmers’ markets to provide customers free or low-cost transportation. Encourage local jurisdictions to lower minimum parking space requirements for food establishments, in exchange for store-initiated transportation alternatives.

- Study barriers to food access and map food and transportation assets. The design and construction of urban spaces has a great impact on human activity. Several factors, both personal and environmental, affect how people perceive their ability to control their activity across space. Environmental factors such as the built environment or community design determine the types of uses that
people will derive from it. Community design themes that either emphasize or undermine pedestrian level amenities such as sidewalks, bicycle lanes and trails for walking and bicycling, or street-level and accessible shopping and food areas, play an important role in how users perceive and interact with that environment (Lopez, 2004; Cervero & Duncan, 2003).

**Lessons Learned from the Study**

The research methodology tested in this study was useful in identifying specific individual’s travel routes and in identifying the food outlets and food service places that formed part of their food environment. However, since most of the participants were first time users of a web-based mapping tool, many found the tool difficult to use to relay accurate information about the location of food outlets visited or routes taken, especially during the first few days of the study. One method that can be used to support this methodology in order to produce more accurate data is to couple it with ‘ground-truthed’ data sources such as Global Positioning System (GPS). Data gathered from devices equipped with GPS can be used to check against the routes digitized in the online maps by users, to increase the accuracy of data and also would act as a back-up when participants forget or do not put in their routes for any particular day. In general ground-truthing provides 20% more accurate data than geocoding alone (Sharkey, 2009), especially in regards to location of outlets and distance traveled.
There is a need for better documentation of food establishments in Polk County. From the study, we found that no single state or local government institution maintains and updates a database of food establishments in Iowa. The data used for this study was acquired from the Iowa Department of Inspections and Appeals, which keeps the information mainly for the purpose of inspecting establishments that prepare and sell food. Those establishments that do not sell cooked food (such as fruit and vegetable stands) were not on the list. Several hours had to be spent on checking the data and ensuring that addresses of the establishments on the list were current and the stores were still open. Also hundreds of establishments on the list did not have any address or had incomplete addresses (missing street name or zipcode), so a large amount of time was spent inputing the current addresses. It is recommended here that an effort to collect data on food establishments from around the state, classify these establishments by type (for example, using the Nutrition Environment Measurement Survey for Stores developed by Glanz et al, 2003) and maintain a proper dataset of current establishments for use by researchers should be undertaken to ensure that the data is accurate.

The research design can be improved by applying measures and checks to ensure reliability and validity. As discussed earlier in Chapter 4, ways to reduce selector bias by increasing random selection should be considered for inclusion in the sampling method. Also, since attrition is a major problem in longitudinal studies such as this one, ways of retaining the participants throughout the length of the study should be considered. Different incentives such as gift cards to a food store or restaurant can be offered to participants who complete the study. The expectation of winning a prize at the end of the study has been found to be a successful way to retain participants in previous studies (Babbie, 2007).
Another area that requires improvement in future research is in the number of participants. The total number of participants for this pilot study was 34 with only 28 completing the entire 5-day duration of the study. Quantitative research studies that have a very small number of participants compromise the ability to generalize the results to the whole population. It may also cause the study results to be skewed, further impeding the generalizability of results. In order to increase the transferability of results from the study, a research design that utilizes random selection, both of neighborhoods to be studied as well as participants to contact, will need to be utilized.

This study also did not perform statistical tests on all possible spatial scales. Important considerations when assessing the food environment is in looking at the food environments of neighboring geographic locations where participants have access to, by measuring spatial autocorrelation. By measuring spatial autocorrelation, studies on the food environment would begin to observe patterns and identify factors that potentially influence nutrition behavior.

**Conclusion**

The development of methodologies and instruments to measure the food environment is the next big step in furthering studies on food access and availability. The ultimate goal of developing a public participation methodology in food environment studies is to include the public in information gathering for the purpose of developing strategies to increase access to food shopping centers and eventually, impact policy making. The public can be involved in
this process at different levels of participation. At the lowest and least intrusive level, the public can be targeted with enhanced information, e.g., about transportation policy that address equity and access issues. At higher levels, the public can be actively solicited to attend focus groups or respond to surveys that seek their views on their immediate food environment, especially around residential and workplace neighborhoods and along transportation corridors. At still higher levels, members of the public may be selected to take part in consultation exercises that provide them with a degree of decision-making authority as to the placement of food outlets in their communities.

The built environment has a significant effect on the health of community residents. Neighborhood characteristics such as the availability and access to healthy food are important mediating factors on the health of residents. As communities develop from simple to complex, general to specialized, from unitary to highly differentiated, the forces shaping the urban environment emanate both from the individual’s interaction with the built environment, as well as the built environment shaping the individual’s behavior.

Since multiple levels of factors influence health behaviors, most times simultaneously and to varying degrees, multi-level interventions that are designed to educate, change or alter beliefs or behavioral skills and formulate policies to support that targeted behavioral change are more effective than single-level interventions. Although considerations of funding, knowledge and skills bottlenecks and time considerations are great impediments of implementing multi-level interventions (Sallis & Owen, 2002), single-level interventions are unlikely to be powerful enough or effective enough to address these multiple factors. Holistic, multi-sectoral interventions that involve different academic disciplines, as well as
public and private sectors, are crucial in the planning, implementation and evaluation of health promoting programs.
APPENDIX A.

ADDITIONAL MATERIAL

I) Letter of Introduction
II) Informed Consent Form
III) Survey Forms
IV) NAICS Classification system for food outlets
I) LETTER OF INTRODUCTION

Research Title:

EXAMINING THE RELATIONSHIP BETWEEN TRANSPORTATION ROUTES AND LOCAL FOOD ENVIRONMENT

Investigator:
Christopher Seeger
Iowa State Extension Specialist and Assistant Professor
Department of Landscape Architecture
Iowa State University

Introduction

Before agreeing to participate in this research study, it is important that you read the following explanation of this study. This statement describes the purpose, procedures, risks and benefits of the program. Also described are the alternative procedures available to you, as well as your right to withdraw from the study at any time.

Explanation of Procedures

You are being asked to take part in a research project to investigate the distribution of and access to grocery stores and fast food outlets within the city of Des Moines. The study will investigate possible correlations that may exist between the location of grocery stores and fast food establishments along one’s daily transportation route and an individual's eating habits.

You have been selected for this study because you live, work and commute within the city of Des Moines or within Polk County. You cannot participate if you are under 18 years of age.

The approach of this research is through the use of two surveys – one initial survey and a daily survey. Your participation will last for five days. You will complete the first survey that contains approximately 14 questions on the first day of the study. This should take about five minutes. These questions are of a general nature asking for family size, type of transportation used, height, weight, etc.

Afterwards, you will be requested to fill out a daily survey where you keep a daily log of your transportation route to and from work for the next five days, including any detours taken to get to any food outlets (grocery store or fast food establishment). The focus of this survey is to find out where you purchase your food, the frequency of purchasing food and the distance traveled to get to the food outlet.
The daily survey includes a user-friendly online mapping tool which will enable you provide a visual display of your daily route. Instructions for using the simple point-and-click map are provided alongside the map. The time required is approximately five minutes and will be completed online.

**Risks and Discomforts**

You will not be at physical or psychological risk and should not experience any discomfort resulting from answering the surveys or using the point-and-click mapping tool. All information gathered in this project will be kept in a secure computer to which only the Investigator has access. No names of participants will be mentioned during or after the research study.

**Benefits**

There are no direct benefits by participating in this project. However, this research is expected to yield valuable information about the accessibility and availability of healthy food options within the Des Moines Metro area.
II) INFORMED CONSENT FORM

TITLE:

EXAMINING THE LOCAL FOOD ENVIRONMENT

This form describes a research project. It has information to help you decide whether or not you wish to participate. Research studies include only people who choose to take part - your participation is completely voluntary. Please discuss any questions you have about the study or about this form with the project staff before deciding to participate.

Who is conducting this study?

This study is being conducted by Christopher Seeger, Assistant Professor in the Department of Landscape Architecture.
This study is funded by Department of Landscape Architecture, Iowa State University

Why am I invited to participate in this study?

You are being asked to take part in this study because you live, work and commute within the city of Des Moines or within Polk County. You should not participate if you are under 18 years of age.

What is the purpose of this study?

The purpose of this study is to investigate the distribution of and access to grocery stores and fast food outlets within the city of Des Moines. The study will investigate possible correlations that may exist between the location of grocery stores and fast food establishments along one’s daily transportation route and an individual's eating habits.

What will I be asked to do?

Your participation will last for five days from 11/07/08 to 11/14/08. Participants will be asked to keep a daily log of their transportation route to and from work over this 5 day period, including any detours taken to get to any food outlets (grocery store or fast food establishment). A user-friendly online mapping tool is provided for this purpose. The time required is approximately five minutes and can be completed online.

Participants are also requested to complete a one-time initial survey that will also take approximately 5 minutes that includes questions on your general information such as family size, type of commute, weight. Participants will also be asked to fill out a daily survey that will focus on where you purchase your food, the frequency of purchasing food and the distance traveled to get to the food outlet.
If you agree to participate, you will be asked to:

i) Complete an initial survey at the beginning of the study that asks for your general information. Participants will also be asked to complete a daily survey that focuses on your use of food outlets on your commute route from your home to work and back. This will include questions on where you purchase your food, what times and days you shop for food and the distance traveled to get to the food outlet.

ii) Complete a daily online ‘journal’ that will include using an online mapping device to draw the route you use on each day during your commute from home to work and work to home including any detours taken to get to a food outlet.

**What are the possible risks and benefits of my participation?**

**Risks**

There is no risk involved in participating in this survey. There is no cost involved to participate in this study.

**Benefits**

You may not receive any direct benefit from taking part in this study. However, we hope that this research will benefit your community by increasing awareness of the food and nutritional resources available and inform State and Local Government on ways in which to improve and enhance community food resources.

**How will the information I provide be used?**

The information you provide will be used to determine the availability of healthy food options in Polk county and their accessibility to community members.

**What measures will be taken to ensure the confidentiality of the data or to protect my privacy?**

**Confidentiality**

You may be assured of complete confidentiality. Your name and address will not be used except for tracking purposes and for sending you the summary of the survey if you request one. Your name will not be disclosed publicly. The data will be kept in a password-protected computer at the Research Park and the result will be presented in aggregate. However, the Iowa State University Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance.
and data analysis. These records may contain private information. In addition, the result of the survey will be reported in aggregate.

**Will I incur any costs from participating or will I be compensated?**

You will not have any costs from participating in this study. You will not be compensated for participating in this study.

**What are my rights as a human research participant?**

Participating in this study is completely voluntary. You may choose not to take part in the study or to stop participating at any time, for any reason, without penalty or negative consequences. You can skip any questions that you do not wish to answer. It will not result in any penalty or loss of benefits to which you are otherwise entitled.

**Whom can I call if I have questions or problems?**

You are encouraged to ask questions at any time during this study.

- For further information about the study contact:

  Christopher Seeger  
  Assistant Professor  
  Landscape Architecture  
  ISU Extension Service  
  (515) 294-3648

- If you have any questions about the rights of research subjects or research-related injury, please contact the IRB Administrator, (515) 294-4566, IRB@iastate.edu, or Director, (515) 294-3115, Office of Research Assurances, 1138 Pearson Hall, Iowa State University, Ames, Iowa 50011.
Consent and Authorization Provisions

Your signature indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document and that your questions have been satisfactorily answered. You will receive a copy of the written informed consent prior to your participation in the study. [The regulations require that a copy of the informed consent document shall be given to the person signing the form. If this is an online survey, please include a statement reminding participants to print a copy of the informed consent for their own files or provide information about where they may obtain a copy.]

Participant’s Name (printed) ______________________________________________________

_________________________________________   ________________________________
(Participant’s Signature)                (Date)

[Include the Parent/Guardian/Legally Authorized Representative signature line only if applicable to your study.]

_________________________________________   ________________________________
(Signature of Parent/Guardian or Legally Authorized Representative)                (Date)

INVESTIGATOR STATEMENT

I certify that the participant has been given adequate time to read and learn about the study and all of their questions have been answered. It is my opinion that the participant understands the purpose, risks, benefits and the procedures that will be followed in this study and has voluntarily agreed to participate.

_________________________________________   ________________________________
(Signature of Person Obtaining Consent)                (Date)
III) SURVEY FORMS

DEMOGRAPHIC SURVEY

Assistant Professor in the Department of Landscape Architecture, Chris Seeger is seeking to test community access to food outlets, routing methodology and health patterns with GIS. The information gathered in this survey will be used to analyze correlations that may exist between the location of grocery stores and fast food establishments along one’s daily transportation route and an individual’s eating habits.

It is also hoped that this pilot project can identify or recommend the type of information needed to successfully launch a larger future study that covers more areas of the state.

Participants will be asked to keep a daily log of their transportation route to and from work over a 5 day period. A user-friendly online mapping tool is provided for this purpose. The time required is approximately five minutes and can be completed online. Participants are also requested to complete a one-time survey that will also take approximately 5 minutes. You may choose to withdraw from this study at any time. You must be at least 18 years old to participate.

Thank you for your participation.

If you have any questions, please feel free to contact Assistant Professor Chris Seeger on email at cjseeger@iastate.edu

Survey

1. Name: _______________________________
2. Address: _______________________________
3. Employment Site: _______________________________
4. Gender: M___ F____
5. What is your age?
   o 20-30
   o 30-40
   o 40-50
   o 50-60
   o 60-70
   o 70+
6. What is the total number of people living in your home?
   - 1
   - 2
   - 3
   - 4+

7. Type of Residence: __________________________

8. Are there children living in your home?
   - Yes
   - No

9. Do you drive alone to and from work or do you carpool?
   - Drive alone
   - Car pool

10. If your route were more accommodating to pedestrians, would you be more likely to walk/bike to work?
    - Yes
    - No

11. What is the approximate distance (in miles) between your home and work place?
    _________________________

12. How many times in the last 5 days have you shopped at a Grocery store?
    - 1
    - 2
    - 3
    - 4+

13. Height: ______________
14. Do you consider yourself to be:
   
   o Underweight
   o Healthy
   o Overweight

15. Weight: __________

16. What is your annual income? (NOTE: This is for analysis purposes only)
   
   o 0-25,000
   o 25,001-50,000
   o 50,001-75,000
   o 75,001-100,000
   o 100,001-125,000
   o 125,000 and over

17. How frequently (number of times per week) do you shop at a grocery store?
   
   o 0
   o 1
   o 2
   o 3
   o 4+

18. How frequently (number of times per week) do you buy food at a fast food establishment?
   
   o 0
   o 1
   o 2
   o 3
19. How convenient is the location of the grocery store(s) on your travel route to and from work?

- Very convenient
- Convenient
- Never buy food at a grocery store
- Inconvenient
- Very inconvenient

20. How convenient is the location of the fast food establishment(s) on your travel route to and from work?

- Very Convenient
- Convenient
- Never buy food at a fast food establishment
- Inconvenient
- Very inconvenient

21. How far off your regular travel route (in miles) do you have to go to the nearest grocery store? __________________________

22. How far off your regular travel route (in miles) do you have to go to the nearest fast food establishment? __________________________

23. How many full-service grocery stores are located within your residential neighborhood?

- 0
- 1
- 2
- 3+
24. How many fast food establishments are located within your residential neighborhood?
   - 1
   - 2
   - 3+

25. If more full service grocery stores were available in your neighborhood, would this impact your diet choices or preferences?
   - Yes
   - No

If you would like to see the results of this pilot study, please provide your email address and an invitation to the final presentation will be sent to you.

Submit
5-DAY SURVEY

Assistant Professor in the Department of Landscape Architecture, Chris Seeger is seeking to test community access to food outlets, routing methodology and health patterns with GIS. The information gathered in this survey will be used to analyze correlations that may exist between the location of grocery stores and fast food establishments along one’s daily transportation route and an individual's eating habits.

It is also hoped that this pilot project can identify or recommend the type of information needed to successfully launch a larger future study that covers more areas of the state.

Participants will be asked to keep a daily log of their transportation route to and from work over a 5 day period. A user-friendly online mapping tool is provided for this purpose. The time required is approximately five minutes and can be completed online. Participants are also requested to complete a one-time survey that will also take approximately 5 minutes. You may choose to withdraw from this study at any time. You must be at least 18 years old to participate.

Thank you for your participation.

If you have any questions, please feel free to contact Assistant Professor Chris Seeger on email at cjseeger@iastate.edu

Survey

What method did you use to commute to work yesterday?

- Automobile
- Bus
- Walk
- Bike
- Other: _________________

TRAVEL ROUTE FROM HOME TO WORK

Follow the following instructions on how to use the mapping tool to draw in your travel route from home to work:

1. Select the day of the week for which you are making the entry:
   - Monday
   - Tuesday
   - Wednesday
   - Thursday
   - Friday
2. Enter your departure and arrival times:
   Departure Time: ___________
   Arrival Time: ___________

3. Click on your starting point on the map shown. Using your mouse, follow the route you took from home to work by pointing-and-clicking every few inches along the streets you travelled. You will see a continuous line indicating the route you used. FOR BEST RESULTS click directly on the street used rather than in the general area.

Day of the week:
   o Monday
   o Tuesday
   o Wednesday
   o Thursday
   o Friday

   Departure Time: ___________
   Arrival Time: ___________

**TRAVEL ROUTE FROM WORK TO HOME**

Follow the following instructions on how to use the mapping tool to draw in your travel route from home to work:

1. Select the day of the week for which you are making the entry

2. Enter your departure and arrival times

3. Enter the number of hours spent at the office **(Do not include any out-of-office meetings/appointments)**

4. Click on your starting point on the map shown. Using your mouse, follow the route you took from home to work by pointing-and-clicking every few inches along the streets you
travelled. You will see a continuous line indicating the route you used. FOR BEST RESULTS click directly on the street used rather than in the general area.

**Editing**: If you would like to edit an entry on the map or start over ..... 

Day of the week:
- Monday
- Tuesday
- Wednesday
- Thursday
- Friday

Departure Time: ___________
Arrival Time: ___________
Number of Hours at the Office
- 0
- 4
- 8

**MAPPING STOPS MADE ALONG TRAVEL ROUTE**

1. Where did you eat the following meals yesterday?

   **BREAKFAST**
   - Home
   - Company Cafeteria
   - Other (INDICATE NAME AND LOCATION ON MAP AND DRAW ROUTE USED TO GET THERE)

   **LUNCH**
   - Home
   - Company Cafeteria
2. Did you have any other stops along your route to/from work yesterday (shop, car maintenance, pick kids from school/day care)? Please indicate purpose of stop and location on MAP

3. Did you shop at a grocery store/food market yesterday?
   - Yes (please indicate grocery/market name and location on map)
   - No
     (this is the menu that goes into the pop-up screens on the map)
   - Breakfast
   - Lunch
   - Dinner
   - Snack
   - Coffee
   - Grocery
### IV) NAICS FOOD STORE CLASSIFICATION SYSTEM

Table 1. North America Industry Classification System (NAICS) codes and examples of food stores and food service places

<table>
<thead>
<tr>
<th>Industry group</th>
<th>1997 NAICS definitions</th>
<th>NAICS index</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supermarkets</td>
<td>445110 Supermarkets and other grocery (except convenience) stores</td>
<td>445110 Supermarkets</td>
<td>Food Lion, Albertson’s, Kroger, Piggly Wiggly, Safeway</td>
</tr>
<tr>
<td>Grocery stores</td>
<td>445110 Supermarkets and other grocery (except convenience) stores</td>
<td>445110 Grocery stores</td>
<td>Beauty Street Grocery, Arkady’s Market, West Side Market, Potomac Grocery, JC Morris Grocery, Kcn’s Grocery</td>
</tr>
<tr>
<td>Convenience stores</td>
<td>445120 Convenience stores</td>
<td>445120 Convenience stores</td>
<td>7-Eleven, 4 Brothers Convenience Store</td>
</tr>
<tr>
<td>Convenience stores with gas stations</td>
<td>447110 Gasoline stations with convenience stores</td>
<td>447110 Gasoline stations with convenience stores</td>
<td>Amoco, Chevron, Shell, Texaco, Sunoco, BP, Cigo, Mobile, Conoco, Exxon, Phillips 66, Davis’s Meat Market, Boonsboro Produce Market, Asia Market, 66 Produce, Holsinger’s Meat Market, Baron’s Gourmet, Valley Street Fish</td>
</tr>
<tr>
<td>Specialty food stores</td>
<td>4452 Specialty food stores</td>
<td>445210 Meat markets</td>
<td>Davis’s Meat Market, Boonsboro Produce Market, Asia Market, 66 Produce, Holsinger’s Meat Market, Baron’s Gourmet, Valley Street Fish</td>
</tr>
<tr>
<td></td>
<td>445220 Fish markets</td>
<td>445230 Fruit/vegetable markets</td>
<td>Davis’s Meat Market, Boonsboro Produce Market, Asia Market, 66 Produce, Holsinger’s Meat Market, Baron’s Gourmet, Valley Street Fish</td>
</tr>
<tr>
<td></td>
<td>445291 Baked goods</td>
<td>445292 Confectionery/nut stores</td>
<td>Davis’s Meat Market, Boonsboro Produce Market, Asia Market, 66 Produce, Holsinger’s Meat Market, Baron’s Gourmet, Valley Street Fish</td>
</tr>
<tr>
<td></td>
<td>445299 All other</td>
<td></td>
<td>Davis’s Meat Market, Boonsboro Produce Market, Asia Market, 66 Produce, Holsinger’s Meat Market, Baron’s Gourmet, Valley Street Fish</td>
</tr>
<tr>
<td>Full-service restaurants</td>
<td>722110 Full-service restaurants</td>
<td></td>
<td>Applebee’s, Baker’s Square, Benihana, Bennigan’s, Bonsai Japanese Steakhouse, The Thai House, Ruby Tuesday, View Street Diner</td>
</tr>
<tr>
<td></td>
<td>722110 Restaurants, full service</td>
<td></td>
<td>Applebee’s, Baker’s Square, Benihana, Bennigan’s, Bonsai Japanese Steakhouse, The Thai House, Ruby Tuesday, View Street Diner</td>
</tr>
<tr>
<td></td>
<td>722110 Steak houses</td>
<td></td>
<td>Applebee’s, Baker’s Square, Benihana, Bennigan’s, Bonsai Japanese Steakhouse, The Thai House, Ruby Tuesday, View Street Diner</td>
</tr>
<tr>
<td></td>
<td>722110 Pizzerias, full service</td>
<td></td>
<td>Applebee’s, Baker’s Square, Benihana, Bennigan’s, Bonsai Japanese Steakhouse, The Thai House, Ruby Tuesday, View Street Diner</td>
</tr>
<tr>
<td></td>
<td>722110 Fine dining restaurants</td>
<td></td>
<td>Applebee’s, Baker’s Square, Benihana, Bennigan’s, Bonsai Japanese Steakhouse, The Thai House, Ruby Tuesday, View Street Diner</td>
</tr>
<tr>
<td></td>
<td>722110 Family restaurants</td>
<td></td>
<td>Applebee’s, Baker’s Square, Benihana, Bennigan’s, Bonsai Japanese Steakhouse, The Thai House, Ruby Tuesday, View Street Diner</td>
</tr>
<tr>
<td></td>
<td>722110 Diners, full service</td>
<td></td>
<td>Applebee’s, Baker’s Square, Benihana, Bennigan’s, Bonsai Japanese Steakhouse, The Thai House, Ruby Tuesday, View Street Diner</td>
</tr>
<tr>
<td></td>
<td>72212 Cafeterias</td>
<td></td>
<td>Applebee’s, Baker’s Square, Benihana, Bennigan’s, Bonsai Japanese Steakhouse, The Thai House, Ruby Tuesday, View Street Diner</td>
</tr>
<tr>
<td>Fast-food restaurants</td>
<td>722211 Limited-service restaurants</td>
<td>722211 Fast-food restaurants</td>
<td>Arby’s, Biscuitville, Bojangles, Burger King, Domino’s, Blimpies, McDonald’s, Wendy’s, Krystal</td>
</tr>
<tr>
<td></td>
<td>722211 Limited-service restaurants</td>
<td></td>
<td>Arby’s, Biscuitville, Bojangles, Burger King, Domino’s, Blimpies, McDonald’s, Wendy’s, Krystal</td>
</tr>
<tr>
<td></td>
<td>722211 Pizza parlor, limited service</td>
<td></td>
<td>Arby’s, Biscuitville, Bojangles, Burger King, Domino’s, Blimpies, McDonald’s, Wendy’s, Krystal</td>
</tr>
<tr>
<td></td>
<td>722211 Pizza delivery shops</td>
<td></td>
<td>Arby’s, Biscuitville, Bojangles, Burger King, Domino’s, Blimpies, McDonald’s, Wendy’s, Krystal</td>
</tr>
<tr>
<td>Carryout eating places</td>
<td>722211 Limited-service restaurants</td>
<td>722211 Delicatessens</td>
<td>Carla’s Deli, Harle’s Subs, Silver Surca’s Sub &amp; Deli, Bagel-Licious, Mr. George’s Sandwich World, Country Deli</td>
</tr>
<tr>
<td>Carryout specialty items</td>
<td>722211 Limited-service restaurants</td>
<td>722211 Sandwich shops</td>
<td>Carla’s Deli, Harle’s Subs, Silver Surca’s Sub &amp; Deli, Bagel-Licious, Mr. George’s Sandwich World, Country Deli</td>
</tr>
<tr>
<td>Carryout specialty items</td>
<td>722211 Bagel shops, full service</td>
<td>722211 Bagel shops</td>
<td>Carla’s Deli, Harle’s Subs, Silver Surca’s Sub &amp; Deli, Bagel-Licious, Mr. George’s Sandwich World, Country Deli</td>
</tr>
<tr>
<td>Carryout specialty items</td>
<td>722213 Snack and nonalcoholic beverage bars</td>
<td>722213 Beverage (e.g., coffee)</td>
<td>Baskin Robbins, Colonial Bakery Store, Papa Vic’s Gelato, Monroe’s Donuts, Snoochee King, TCBY Yogurt, Dunkin, Dunkin’s, Starbucks Coffee, Gloria Jean’s Coffee, Fanny Farmer’s Candies</td>
</tr>
<tr>
<td>Carryout specialty items</td>
<td>722213 Beverage (e.g., coffee) bars (nonalcoholic)</td>
<td>722213 Doughnut shops</td>
<td>Baskin Robbins, Colonial Bakery Store, Papa Vic’s Gelato, Monroe’s Donuts, Snoochee King, TCBY Yogurt, Dunkin, Dunkin’s, Starbucks Coffee, Gloria Jean’s Coffee, Fanny Farmer’s Candies</td>
</tr>
<tr>
<td>Carryout specialty items</td>
<td>722213 Ice cream parlors</td>
<td>722213 Ice cream parlors</td>
<td>Baskin Robbins, Colonial Bakery Store, Papa Vic’s Gelato, Monroe’s Donuts, Snoochee King, TCBY Yogurt, Dunkin, Dunkin’s, Starbucks Coffee, Gloria Jean’s Coffee, Fanny Farmer’s Candies</td>
</tr>
<tr>
<td>Carryout specialty items</td>
<td>722213 Pretzel shops</td>
<td>722213 Pretzel shops</td>
<td>Baskin Robbins, Colonial Bakery Store, Papa Vic’s Gelato, Monroe’s Donuts, Snoochee King, TCBY Yogurt, Dunkin, Dunkin’s, Starbucks Coffee, Gloria Jean’s Coffee, Fanny Farmer’s Candies</td>
</tr>
<tr>
<td>Bars and taverns</td>
<td>722411 Drinking places (alcoholic beverages)</td>
<td>722410 Alcoholic beverage drinking places</td>
<td>McBare’s Pub, South End Tavern, Club City Lights, Eddie’s Disco, Sportsmen’s Den, Funktown Tavern</td>
</tr>
</tbody>
</table>
APPENDIX B. STATISTICAL RESULTS

ANOVA TEST FOR RELATIONSHIP BETWEEN DISTANCE TRAVELLED AND GROCERY VISITS

Equation: Standard Curves, Linear Curve
\( f = y_0 + ax \)

**Dynamic Fit Options:**
- Total Number of Fits: 200
- Maximum Number of Iterations: 200

**Parameter Ranges for Initial Estimates:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y_0 )</td>
<td>-1.2176</td>
<td>3.6529</td>
</tr>
<tr>
<td>( a )</td>
<td>-0.0347</td>
<td>0.1041</td>
</tr>
</tbody>
</table>

**Summary of Fit Results:**
Converged: 100.0%

**Results for the Overall Best-Fit Solution:**

<table>
<thead>
<tr>
<th>R</th>
<th>Rsqr</th>
<th>Adj Rsqr</th>
<th>Standard Error of Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3453</td>
<td>0.1192</td>
<td>0.0898</td>
<td>0.8605</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t</th>
<th>P</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y_0 )</td>
<td>1.2176</td>
<td>0.2650</td>
<td>4.5948</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>( a )</td>
<td>0.0347</td>
<td>0.0170</td>
<td>2.0378</td>
<td>0.0505</td>
</tr>
</tbody>
</table>

**Analysis of Variance:**

Uncorrected for the mean of the observations:

<table>
<thead>
<tr>
<th></th>
<th>SS</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>90.7874</td>
<td>45.3937</td>
</tr>
<tr>
<td>Residual</td>
<td>22.2126</td>
<td>0.7404</td>
</tr>
<tr>
<td>Total</td>
<td>113.0000</td>
<td>3.5313</td>
</tr>
</tbody>
</table>

Corrected for the mean of the observations:

<table>
<thead>
<tr>
<th></th>
<th>SS</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>3.0061</td>
<td>3.0061</td>
</tr>
<tr>
<td>Residual</td>
<td>22.2126</td>
<td>0.7404</td>
</tr>
<tr>
<td>Total</td>
<td>25.2188</td>
<td>0.8135</td>
</tr>
</tbody>
</table>

**Statistical Tests:**

- PRESS: 24.7935
- Durbin-Watson Statistic: 2.1630 Passed
- Normality Test: Passed (P = 0.5646)
- K-S Statistic = 0.1359 Significance Level = 0.5646
Scatter plot of frequency of grocery visits vs Work travel distance (miles)
ANOVA TEST FOR RELATIONSHIP BETWEEN DISTANCE TRAVELLED AND FREQUENCY OF PURCHASING OUT-OF-HOME FOOD

Equation: Standard Curves, Linear Curve
\[ f = y_0 + a \times x \]

Dynamic Fit Options:
- Total Number of Fits: 200
- Maximum Number of Iterations: 200

Parameter Ranges for Initial Estimates:
- Minimum: y0-2.2365, a -0.0123
- Maximum: y0 6.7094, a 0.0368

Summary of Fit Results:
- Converged: 100.0%

Results for the Overall Best-Fit Solution:

<table>
<thead>
<tr>
<th>R</th>
<th>Rsqr</th>
<th>Adj Rsqr</th>
<th>Standard Error of Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0872</td>
<td>0.0076</td>
<td>0.0000</td>
<td>1.5173</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t</th>
<th>P</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>y0</td>
<td>2.2365</td>
<td>0.4261</td>
<td>5.2488</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>a</td>
<td>0.0123</td>
<td>0.0243</td>
<td>0.5035</td>
<td>0.6180</td>
</tr>
</tbody>
</table>

Analysis of Variance:

Uncorrected for the mean of the observations:

<table>
<thead>
<tr>
<th>DF</th>
<th>SS</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>2</td>
<td>198.3298</td>
</tr>
<tr>
<td>Residual</td>
<td>32</td>
<td>73.6702</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>272.0000</td>
</tr>
</tbody>
</table>

Corrected for the mean of the observations:

<table>
<thead>
<tr>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>0.5651</td>
<td>0.5651</td>
<td>0.2455</td>
</tr>
<tr>
<td>Residual</td>
<td>32</td>
<td>73.6702</td>
<td>2.3022</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>74.2353</td>
<td>2.2496</td>
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</tbody>
</table>

Statistical Tests:

<table>
<thead>
<tr>
<th>PRESS</th>
<th>83.1323</th>
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</thead>
<tbody>
<tr>
<td>Durbin-Watson Statistic</td>
<td>1.9118</td>
</tr>
<tr>
<td>Normality Test</td>
<td>Passed</td>
</tr>
<tr>
<td>K-S Statistic</td>
<td>0.1934</td>
</tr>
</tbody>
</table>
Scatter plot of frequency of purchasing fast food vs Work travel distance (miles)
### Rank Sum Test

**Distance travelled and frequency of purchasing out-of-home food**

17:37 Sunday, August 9, 2009

Effect of distance travelled with freqfast 1

The NPAR1WAY Procedure
Wilcoxon Scores (Rank Sums) for Variable freqout
Classified by Variable group

<table>
<thead>
<tr>
<th>group</th>
<th>N</th>
<th>Sum of Scores</th>
<th>Expected Under H0</th>
<th>Std Dev Under H0</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>222.50</td>
<td>245.00</td>
<td>27.45035</td>
<td>15.892857</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
<td>244.00</td>
<td>227.50</td>
<td>27.109675</td>
<td>18.769231</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>128.50</td>
<td>122.50</td>
<td>22.556613</td>
<td>18.357143</td>
</tr>
</tbody>
</table>

Average scores were used for ties.

Kruskal-Wallis Test

Chi-Square: 0.6801
DF: 2
Asymptotic Pr > Chi-Square: 0.7117
Exact Pr >= Chi-Square: 0.7225

Effect of distance travelled with freqfast 2

17:37 Sunday, August 9, 2009

The NPAR1WAY Procedure
Median Scores (Number of Points Above Median) for Variable freqout
Classified by Variable group

<table>
<thead>
<tr>
<th>group</th>
<th>N</th>
<th>Sum of Scores</th>
<th>Expected Under H0</th>
<th>Std Dev Under H0</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>6.0</td>
<td>7.00</td>
<td>1.273618</td>
<td>0.428571</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
<td>7.0</td>
<td>6.50</td>
<td>1.257597</td>
<td>0.538462</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>4.0</td>
<td>3.50</td>
<td>1.046384</td>
<td>0.571429</td>
</tr>
</tbody>
</table>

Average scores were used for ties.

Median One-Way Analysis

Chi-Square: 0.6416
DF: 2
Asymptotic Pr > Chi-Square: 0.7256
Effect of distance travelled with freqfast 3

17:37 Sunday, August 9, 2009

The NPAR1WAY Procedure
Van der Waerden Scores (Normal) for Variable freqout
Classified by Variable group

<table>
<thead>
<tr>
<th>group</th>
<th>N</th>
<th>Sum of Scores</th>
<th>Expected Under H0</th>
<th>Std Dev Under H0</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>-2.053293</td>
<td>0.0</td>
<td>2.474472</td>
<td>-0.146664</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
<td>1.594425</td>
<td>0.0</td>
<td>2.443345</td>
<td>0.122648</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>0.458868</td>
<td>0.0</td>
<td>2.032986</td>
<td>0.065553</td>
</tr>
</tbody>
</table>

Average scores were used for ties.

Van der Waerden One-Way Analysis
Chi-Square 0.7085
DF 2
Asymptotic Pr > Chi-Square 0.7017
Exact Pr >= Chi-Square 0.7134
Effect of distance travelled with freqfast 4

17:37 Sunday, August 9, 2009

The NPAR1WAY Procedure
Savage Scores (Exponential) for Variable freqout
Classified by Variable group

<table>
<thead>
<tr>
<th>group</th>
<th>N</th>
<th>Sum of Scores</th>
<th>Expected Under H0</th>
<th>Std Dev Under H0</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>-1.583067</td>
<td>0.0</td>
<td>2.539036</td>
<td>-0.113076</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
<td>1.611941</td>
<td>0.0</td>
<td>2.507098</td>
<td>0.123995</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>-0.028875</td>
<td>0.0</td>
<td>2.086031</td>
<td>-0.004125</td>
</tr>
</tbody>
</table>

Average scores were used for ties.

Savage One-Way Analysis
Chi-Square 0.4842
DF 2
Asymptotic Pr > Chi-Square 0.7850
Exact Pr >= Chi-Square 0.8014
Rank Sum Test

Density of food outlets and number of stops

Density of food outlets and number of stops 1
17:37 Sunday, August 9, 2009
The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable freqstops
Classified by Variable density

<table>
<thead>
<tr>
<th>density</th>
<th>N</th>
<th>Sum of Scores</th>
<th>Expected Under H0</th>
<th>Std Dev Under H0</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>239.00</td>
<td>248.00</td>
<td>17.708755</td>
<td>14.937500</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>127.50</td>
<td>108.50</td>
<td>15.013327</td>
<td>18.214286</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>98.50</td>
<td>108.50</td>
<td>15.013327</td>
<td>14.071429</td>
</tr>
</tbody>
</table>

Average scores were used for ties.

Kruskal-Wallis Test
Chi-Square               1.6886
DF                      2
Asymptotic Pr > Chi-Square 0.4299
Exact Pr >= Chi-Square   0.4915

Density of food outlets and number of stops 2
17:37 Sunday, August 9, 2009

The NPAR1WAY Procedure
Median Scores (Number of Points Above Median) for Variable freqstops
Classified by Variable density

<table>
<thead>
<tr>
<th>density</th>
<th>N</th>
<th>Sum of Scores</th>
<th>Expected Under H0</th>
<th>Std Dev Under H0</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>7.521739</td>
<td>8.00</td>
<td>0.766620</td>
<td>0.470109</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>4.391304</td>
<td>3.50</td>
<td>0.649934</td>
<td>0.627329</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>3.086957</td>
<td>3.50</td>
<td>0.649934</td>
<td>0.440994</td>
</tr>
</tbody>
</table>

Average scores were used for ties.

Median One-Way Analysis
Chi-Square               1.9331
DF                      2
Asymptotic Pr > Chi-Square   0.3804  
Exact   Pr >= Chi-Square   0.5107  
Density of food outlets and number of stops 3  

17:37 Sunday, August 9, 2009  

The NPAR1WAY Procedure  
Van der Waerden Scores (Normal) for Variable freqstops  
Classified by Variable density  

<table>
<thead>
<tr>
<th>density</th>
<th>N</th>
<th>Sum of Scores</th>
<th>Expected Under H0</th>
<th>Std Dev Under H0</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td></td>
<td>0.0</td>
<td>1.874804</td>
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<tr>
<td>2</td>
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<td>0.0</td>
<td>1.589443</td>
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</tr>
<tr>
<td>3</td>
<td>7</td>
<td>-1.099823</td>
<td>0.0</td>
<td>1.589443</td>
<td>-0.157118</td>
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</table>

Average scores were used for ties.  

Van der Waerden One-Way Analysis  
Chi-Square   1.4363  
DF   2  
Asymptotic Pr > Chi-Square   0.4876  
Exact   Pr >= Chi-Square   0.4915  
Density of food outlets and number of stops 4  

17:37 Sunday, August 9, 2009  

The NPAR1WAY Procedure  
Savage Scores (Exponential) for Variable freqstops  
Classified by Variable density  

<table>
<thead>
<tr>
<th>density</th>
<th>N</th>
<th>Sum of Scores</th>
<th>Expected Under H0</th>
<th>Std Dev Under H0</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>-0.279263</td>
<td>0.0</td>
<td>2.320297</td>
<td>-0.017454</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>1.703021</td>
<td>0.0</td>
<td>1.967127</td>
<td>0.243289</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>-1.423757</td>
<td>0.0</td>
<td>1.967127</td>
<td>-0.203394</td>
</tr>
</tbody>
</table>

Average scores were used for ties.  
Savage One-Way Analysis  
Chi-Square   0.9830  
DF   2  
Asymptotic Pr > Chi-Square   0.6117  
Exact   Pr >= Chi-Square   0.7055  
BIBLIOGRAPHY


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