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A Quantitative Assessment of Livability Principles for Neighborhood-Level Analysis

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A QUANTITATIVE ASSESSMENT OF LIVABILITY PRINCIPLES FOR NEIGHBORHOOD-LEVEL ANALYSIS

by
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Abstract

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The Partnership for Sustainable Communities, which includes the United States Department of Transportation (DOT), Housing Urban Development (HUD), and the Environmental Protection Agency (EPA), has established six principles of livability. The principles are defined in a qualitative way, and limited research exists to establish a quantitative measurement of livability goals. This research develops a quantitative metric to assess the six livability principles and applies the metric to measure the livability of Memphis, Tennessee neighborhoods. The results are compared to existing residential survey data for the Memphis area to determine how well the defined livability principles align with residential stakeholder perceptions of livability. This research indicates that there is an apparent discrepancy between the established livability principles and the values of community residents related to livability.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Livability is a concept that encompasses a broad range of factors affecting the quality of life in a community. Numerous organizations have developed definitions of livability, with the most prominent being the Partnership for Sustainable Communities between the United States Departments of Transportation (DOT), Housing and Urban Development (HUD), and the Environmental Protection Agency (EPA). This partnership resulted in six livability principles that are used to make decisions and form opinions about neighborhoods. The principles were developed incorporating best of practice programs that have been successfully implemented.

The improvement of livability in a community is of interest to community members, government officials, government agencies, engineers and developers. A method for measuring livability would enhance the decision-making ability of community stakeholders regarding policy and funding choices. The ability to accurately assess community livability allows for comparisons, analysis, and more informed and data driven decisions to be made. Improved livability is the driving force of change and development in a neighborhood. While there have been many studies conducted regarding defining livability and case studies exist examining efforts to improve livability of communities, there is limited research regarding the actual translation of established principles to a quantitative metric for assessment.

The concept of livability has been defined in a qualitative way and is used as justification for funding allocations and grant applications for large capital projects. The ability to quantitatively measure livability would provide municipal decision makers with a tool to inform decisions regarding potential projects under consideration for funding. It would also establish a means for quantitative analysis of before and after conditions such that project impact could be evaluated. The purpose of this research is to translate livability principles that have been established by the Partnership for Sustainable Communities into quantitative indicators. The metric developed through this research will be applied to communities in Memphis, Tennessee to measure the livability at the neighborhood level. The scores will then be compared to residential surveys from a previous project in the Memphis area to investigate metric validity.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Review

The concept of livability can be found in the news and on magazine covers with tag lines similar to: where to live, best places to live, highest livability scores, etc. It was not until recently that the agencies responsible for community development took an interest in the concept of livability. Many agencies have defined livability. One of the most well-known definitions was established by the US Secretary of Transportation Ray LaHood who stated, “Livability means being able to take your kids to school, go to work, see a doctor, drop by the grocery or post office, go out to dinner and a movie, and play with the kids at the park- all without having to get in your car” (U.S. Department of Transportation (DOT) 2013). Although this definition works well in urban communities, it is unlikely to be feasible in a rural community. A literature review conducted by the United States Department of Transportation (USDOT) and the Federal Highway Administration (FHWA) uncovered the way the term ‘livability’ came about as a way to describe tactics that governments and organizations use to achieve sustainability or quality of life (The National Asscіation of Regional Councils n.d.). Another example of a livability definition is put forth by the Chicago Metropolitan Agency for Planning (CMAP). Livable communities are defined by CMAP as communities that are “healthy, safe and walkable, offer transportation choices that provide timely access to schools, jobs, services, and basic needs” (Chicago Metropolitan Agency For Planning 2010).

Many tools and programs have been implemented in hopes of improving livability in communities, with many of these being established before livability became a hot topic. These include Smart Growth, Complete Streets, Lifelong Communities, Safe Routes to Schools, Context Sensitive Solutions/Design, New Urbanism, and Transit-Oriented Development (The National Assciation of Regional Councils n.d.) The following sections outline these principles and practices, and the context through which livability is addressed.

2.2 Smart Growth

The goal of having a community that works for everyone and is able to support businesses and jobs is an example of an approach to improving livability. Smart Growth is one example of a way to make an area more livable. The concept of 'Smart Growth' dates back to the 1970's, and the actual term came into use as early as 1986 (Flint 2011). The goal of Smart Growth is to "create healthy communities with strong local businesses, schools and shops nearby, transportation options and jobs that pay well" (Smart Growth America 2014). Some of the initiatives of smart growth are to provide an increase in sidewalks and to ensure that more homes are constructed near public transit, thereby reducing the need for personal vehicles and improving the environment and roadway network congestion. The application of mixed land uses, creation of housing choices, walkable neighborhoods, and providing many different transportation choices are all examples of Smart Growth applications (Environmental Protection Agency 2013).

2.3 Complete Streets

Complete Streets is another example of how communities are improving their livability. The concept of Complete Streets was first addressed in the Oregon Department of Transportation “Bike Bill” in 1971. The bill required all new roadways that were being built or rebuilt to include pedestrian and bicycle facilities (Oregon Department of Transportation n.d.). This livability practice also focuses on improvements in the transportation system. The goal is to provide access for all modes of transportation. “Nearly one-third of the U.S. population is transportation disadvantaged, which means that they cannot easily access basic needs such as healthy food choices, medical care, gainful employment, and educational opportunities” (Burden and Litman April 2011). The FHWA identifies the complete streets program as a good place to start when discussing livability in transportation. The ability to move people in a safe way from home to any location that fits their basic need is a main goal when discussing the improvement of livability in a community (Federal Highway Administration (FHWA) n.d.). As a result, there are 610 jurisdictions around the United States that contain a Complete Streets policy (Smart Growth America 2014).

2.4 Lifelong Communities

The goal of lifelong communities is to provide an environment in the community that would be better for all people despite their age (Partners for Livable Communities 2014). An example of this is being applied in Atlanta, Georgia where they have established three major goals: promote housing and transportation options, encourage healthy lifestyles, and expand information and

access to services for all community residents (Partners for Livable Communities 2014). The expected outcome is for communities to be able to meet the needs of all in the community. Some examples would be the types of housing options that are available in the community and the ability to meet the transportation needs of those who do not drive.

2.5 Safe Routes to School

The focus on children's safety first was highlighted in the United States through a publication by the US DOT in 1975 titled "School Trip Safety and Urban Play Areas" (National Center for Safe Routes to School,*Mission*, n.d.). The program Safe Routes to School did not get established in the US until 1997 in Bronx, N.Y. (National Center for Safe Routes to School,*History*, n.d.). The Safe Routes to School program is a national effort to improve the health and well-being of children by enabling and encouraging them to walk and bicycle to school. The focus is to improve safety and accessibility in the journey to school, that ties into the improvement of the livability in the community. A goal is also to reduce the number of vehicles queued at schools which will reduce the air pollution around schools (National Center for Safe Routes to School n.d.). It became a national program in 2005 when Congress passed the legislation that made the program an effort at local, regional and national levels. Since then, data from around the country have been collected through state coordination and through an increase in local programs, and advocates there has been an overall increase in knowledge for best practices to improve the safety of children

walking and biking to school (National Center for Safe Routes to School,*Progress*, n.d.).

2.6 Context Sensitive Solutions/Designs

Context Sensitive Solutions can be traced back to 1969, but did not gain momentum until the late 1990's to early 2000's. In 2004, the website for context sensitive solutions was launched along with a best of practice guide (U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) 2005). Similar to the previously mentioned initiatives, the concept of Context Sensitive Solutions (CSS) emergent with the intent to change the approach to planning and design of transportation projects. "CSS respects design objectives for safety, efficiency, capacity and maintenance while integrating community objectives and values relating to compatibility, livability, sense of place, urban design, cost and environmental impacts" (Institute of Transportation Engineers 2005). Examples of CSS range from accessible pedestrian signals, inclusion of bicycle facilities, road grade separation, bulbouts, planted medians and new interchange designs to include soundwalls (U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) 2005). All of these infrastructure improvements and more make the roadway more accessible to all users, decrease the impact on the environment, and improve the appearance of the roadway.

2.7 New Urbanism

The Congress for the New Urbanism (CNU) is an organization with the goal of promoting walkable, mixed-use neighborhood development, sustainable

communities and healthy living conditions (Concress for the New Urbanism 2011). This organization has existed for over twenty years, and one of their 'hallmarks' is to promote livable streets arranged in compact, walkable blocks. The CNU was founded in 1993, with the goal of creating long-lasting neighborhoods. One example of a good application of this is a redevelopment of a former public housing project in Memphis, TN. The location was transformed into a 473-unit mixed-income housing development that was recognized as the first of its kind in Tennessee. This new development provided housing that was affordable and contained established connectivity for residents to access basic needs (Murray 2011).

2.8 Transit Oriented Development

Transit Oriented Development is a concept that has been around for a long time, but did not become the slogan that it is today until the late 1980's. The slogan for this organization is to "design for a livable sustainable future". The overall goal is to end urban sprawl and to bring people back to the cities to promote the use of public transit and to make communities more walkable (Transit Oriented Development n.d.). One example of a successful Transit Oriented Development is in San Diego where a transit oriented neighborhood was developed with the intention of removing personal vehicles off of the roadway to improve the environment and roadway services (Reconnecting America n.d.).

All of the above programs were used to develop the current livability definition. The interest in increasing livability in communities is evident by the

number of organizations and initiatives devoted to establishing mechanisms for achieving greater livability. There have been many different iterations of the livability definition, and consequently the US government recognized the need for cohesion. As such, the US Department of Transportation (DOT), The US Environmental Protection Agency (EPA), and the US Department of Housing and Urban Development (HUD) formed a partnership for Sustainable Communities (U.S. Environmental Protection Agency 2014). The partnership defined livability using 6 key principles that represent the programs previously described. The six key livability principles are: “provide more transportation choices; promote equitable, affordable housing; enhance economic competitiveness; support exiting communities; coordinate and leverage federal policies and investment; and value communities and neighborhoods” (U.S. Environmental Protection Agency 2014).

The interest in increasing livability in communities is evident by the number of organizations and initiatives devoted to establishing mechanisms for achieving greater livability. Accordingly, many communities are now focusing on increasing livability and are trying to address this through a variety of approaches that are previously discussed. Once important reasoning behind the focus on livability is the government funding attached to livability. A Federal Resources for Sustainable Rural Communities document gives a summary of 120 grants and loans that are all tied to the 6 livability principles (Partnership for Sustainable Communities, U.S. Department of Agriculture n.d.). The principles are each

defined in a few short sentences and then through case study examples published on the FHWA website.

2.9 Case Studies on Livability Principles

The Partnership for Sustainable Communities collected case studies as examples of the livability principles. The case studies are categorized based upon whether or not they include land use, roadway design, parks and recreation, complete streets, bicycle and pedestrian, transit, or other neighborhood approaches. The definition of Principle 1 is to "develop safe, reliable and economical transportation choices to decrease household transportation costs, reduce our nation's dependence on foreign oil, improve air quality, reduce greenhouse gas emissions, and promote public health" (U.S. Environmental Protection Agency 2014). Principle 1 case studies depicted examples of providing transportation options through bike and pedestrian facility improvements (U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) 2014). These case studies addressed redesigns with the intention of decreasing congestion on a major roadway and the application of complete streets design. Table 1 presents a summary of the case studies identified as being supportive of Principle 1.

Table 1. Principle 1 Case Studies (U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) 2014)

Principle 1	Land Use	Road	Parks and	Complete	Bike	Transit	Neighbor - hood	Summary
Cheyenne Wyoming	x	x	x	x	x			Improve pedestrian facilities using

Principle 1	Land Use Road	Parks and Complete	Bike	Transit	Neighbor - hood	Summary
						a complete streets approach. Provide a pedestrian network.
Dallas-Fort Worth			x			Publication of a bike plan with the goal of developing bike and pedestrian (ped) facilities. Growth and the intent to grow with more bike and ped facilities is supported by the community.
Greenwood, MS	x		x			Improvement of quality of life downtown with new and improved ped facilities.
Knoxville, TN			x			Increase the bike as a mode of transportation through infrastructure, signage, and education.
Miami to Ft. Lauderdale FL	x			x		Reduce the congestion on major interstate by implementing programs like High Occupancy Toll, transit incentives, and ramp signaling.
San Francisco CA	x	x	x	x		Complete streets campaign to reclaim streets, parks, and neighborhoods to improve design, safety and public spaces that support bike, ped, and transit.
One Bay Area	x		x	x		Improve pedestrian facilities, local streets, transportation, safe routes to school, and planning and outreach activities.
Seattle WA			x	x		Promote a drive less program that promotes: walking, biking, metro subway, ferry, carpooling, and car sharing.
St. Louis	x				x	Reconstruction of major interstates to reduce congestion and make it easier to travel between surrounding states. Improve connection to neighborhoods.

Principle 2 states the need to "expand location- and energy-efficient housing choices for people of all ages, incomes, races, and ethnicities to increase mobility and lower the combined cost of housing and transportation" (U.S. Environmental Protection Agency 2014). Case studies show examples of improvement to transit to serve more communities and the development of affordable housing. Table 2 presents the case studies found by The Partnership for Sustainable Communities to be supportive of Principle 2.

Table 2. Principle 2 Case Studies (U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) 2014)

Principle 2	Complete	Bike/Ped	Tansit	neighbor	affordable housing	Summary
Fairmount Boston			x		x	Reconfiguration of rail line that serve urban neighborhoods into rapid transit.
Denver CO			x	x		Establish a new transit line and extend existing along with bus rapid transit.
Kansas City Mo			x			More transportation options through bus rapid transit.
Los Angeles, CA			x		x	Transit Oriented Development included 450 apartments (90 affordable), improved transit with subway system
Redmond WA			x			Transit Oriented Development included 308 affordable housing units, 536 shared resident and park-and-ride users.
Somerville, MA	x	x				Road-Diet for roadway running the complete length of the town to provide a complete streets concept

Principle 3 is defined as the need to "improve economic competitiveness through reliable and timely access to employment centers, educational

opportunities, services and other basic needs by workers, as well as expanded business access to markets" (U.S. Environmental Protection Agency 2014). The case studies for principle 3 contain examples of redevelopments, funding and policy strategy's, and increasing capacity on roadways, as shown in Table 3.

Table 3. Principle 3 Case Studies (U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) 2014)

Principle 3	Land Use	Road Design	Complete	Bike/Ped	Transit	Historic District	Funding	Summary
Dubuque IA	x		x	x	x	x		Redeveloped the warehouse/historic district on the river to include compete streets, mix of uses for buildings, and city culture
N Central Pennsylvania		x		x				Policy and funding to meet their Regional Action Strategy in smart transportation and safe routes to school.
Perham, MN		x					x	Through a TED grant the construction of a multi-use trail and interchange improvement
San Bernardino, CA		x						Highway widening to increase highway's capacity and operations

Principle 4 is defined by the goal of "targeting federal funding towards existing communities - through strategies like transit-oriented, mixed use development and land recycling - to increase community revitalization and the efficiency of public works investments and safeguard rural landscapes" (U.S.

Environmental Protection Agency 2014).The case studies are examples of policies and funding, planning, and roadway designs and improvements, as highlighted in Table 4.

Table 4. Principle 4 Case Studies (U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) 2014)

Principle 4	Land Use	Road Design Complete	Bike/Ped	Transit	Funding Policies	Summary
Atlanta, GA			x		x	With the goal of eliminating Urban Sprawl research funding and funds being used to improve city pedestrian facilities
CA, TN, WA					x	Three DOT create the Office of Community Transportation to make more livable communities by developing plans that incorporate the needs of communities
Kentucky's Bluegrass Region		x			x	Development of a Pike
Raleigh NC		x	x	x		Improve travel of multi modes for short and long distances. Coordination of land use and transportation projects. Improved roadway design to accommodate higher volumes, traffic calming to decrease the local residential cut through traffic.
Wilmington, DE	x	x	x			Introduction of a roadway that provides access to local parks and implementation of traffic calming to ensure low speeds. Provide bike path and pedestrian route for connection with a spur road.

Principle 5 is defined with the goal to "align federal policies and funding to remove barriers to collaboration, leverage funding, and increase the accountability and effectiveness of all levels of government to plan for future growth, including making smart energy choices such as locally generated renewable energy" (U.S. Environmental Protection Agency 2014). Table 5 features a summary of the case studies, showing examples of grants, systems, and agencies working together to accomplish a common goal.

Table 5. Principle 5 Case Studies (U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) 2014)

Principle 5	Road Design	Parks and Rec	Bike/Ped	Transit	Historic District	Funding	Summary
Bridgeport CT	x		x	x			Received a TIGER grant to improve two neighborhoods through pedestrian and bike friendly streets that connect neighborhoods to public transit.
Kansas City, MO-KS						x	Development of 100 point scoring system to ensure each project is addressing their LRTP.
Montgomery, AL		x			x	x	Redeveloped an industrial area into a park with the help of many agencies partnerships and funding.

The goal of Principle 6 is to "enhance the unique characteristics of all communities by investing in healthy, safe, and walkable neighborhoods - rural, urban or suburban" (U.S. Environmental Protection Agency 2014). The case studies show examples where the community members promoted change in the roadway design, as demonstrated in Table 6.

Table 6. Principle 6 Case Studies (U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) 2014)

Principle 6	Land Use	Road Design	Parks and Rec	Complete Streets	Bike/Ped	neighbor hood associatio	Summary
Hailey, ID				x			A pet getting hit and killed by a vehicle prompted the citizens to approach the city and get a redesign that included pedestrian facilities on a popular roadway.
Letcher County, KY						x	The residents wanted improvements done on a mountain road that was dangerous. They wanted it widened and environmentalist did not because of the mountain. As a result they did spot improvements on curves making it overall safer.
Maine's Mid Coast		x	x				Promoting mixed-used communities; implementing minimum lot size and frontage requirements that have a direct impact on transportation; building schools, day care centers and recreation areas near neighborhoods; planning large retail activities near interstate interchanges; creating opportunities to co-locate public facilities; designing neighborhood streets to a smaller scale than state roads; adopting driveway and entrance location and design standards; and preserving open space plans for large lot sizes.

Principle 6	Land Use	Road Design	Parks and Rec	Complete Streets	Bike/Ped	neighbor hood associatio	Summary
Missoula, MT	x			x	x		Designing for the future growth through policies, complete street projects, redevelopment, ped and bike facilities and traffic flow designs.
New York, NY					x		To improve the safety of adult pedestrian crashes the infrastructure was improved along with roadway redesigns to reduce speeds and the installation of new pedestrian safety features.

The above case studies provide examples and qualitative assessments of the six livability principles established through the partnership for Sustainable Communities. However, there is a lack of uniformity in the case studies that are intended to help define the principles. There is also significant overlap with the concepts being addressed in the case studies.

In addition, there are very few published examples for quantifying livability principles. In 2013, the Berkeley Planning Journal published a study that associated the new Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND) with Livability (Elizabeth Clark, et al. 2013). The LEED-ND program establishes a set of credits which evaluate neighborhoods on five considerations: smart location and linkage, neighborhood pattern and design, green infrastructure and building, innovation and design, and regional priority. The focus of the study was to determine how well the LEED-ND captured livability. This was assessed using the LEED-ND criterion, which is the

newest rating system for the US Green Building Council (USGBC), and comparing the results to residential survey data collected from the case study location. The LEED-ND Credits are shown in Table 7 below.

Table 7. LEED-ND Neighborhood Pattern and Design Criteria (Elizabeth Clark, et al. 2013)

LEED-ND Credits		Point(s) Possible
Credit 1	Walkable Streets	12
Credit 2	Compact Development	6
Credit 3	Mixed-Use Neighborhood Centers	4
Credit 4	Mixed-Income Diverse Communities	7
Credit 5	Reduced Parking Footprint	1
Credit 6	Street Network	2
Credit 7	Transit Facilities	1
Credit 8	Transportation Demand Management	2
Credit 9	Access to Civic and Public Space	1
Credit 10	Access to Recreation Facilities	1
Credit 11	Visitability and Universal Design	1
Credit 12	Community Outreach and Involvement	2
Credit 13	Local Food Production	1
Credit 14	Tree-lined and shaded streets	2
Credit 15	Neighborhood Schools	1

The ratings given to each credit were done in an objective way using many mapping tools and personal assessments, for instance, Google Maps and GIS. The area assessed was given a livability rating out of a possible 44 points. The rating was compared to 40 neighborhood surveys. The survey asked residents to rank the LEED-ND's 15 criteria along with open-ended questions about background information of the resident, including for example, how long the respondent had lived in the neighborhood. Comparing the LEED-ND ratings with the neighborhood surveys resulted in the conclusion that the 15-credit criterion

and the possible scores that were allotted to each credit did not accurately capture the livability of the neighborhood because it did not relate to the livability principles.

The establishment of indicators is important to be able to quantify livability. A report in the Journal of Transport Geography provided a guideline for applying quantitative livability and sustainability indicators. The report also provided recognition that the six livability principles established by the Partnership for Sustainable Communities are objectives that contain an unstated definition that covers economic, social, and environmental dimensions. The attributes associated with livability can vary from place to place; as a result it is suggested that the relative weight of livability attributes can also vary from place to place (J. Miller, Witlox and P. Tribby 2013). This makes the development of a standardized approach to assessing community livability quite challenging. The comparison of their metrics to the 6 key livability principles is shown in Table 8.

Table 8. Summary Comparison of Case Studies to Established Livability Principles

Six Livability Principles	LEED
Provide more transportation options	X
Promote equitable, affordable housing	X
Enhance economic competitiveness	
Support existing communities	X
Coordinate and leverage federal policies an investment	
Value Communities	X
Notes about the study	Small study group.

The need to have a standard way to measure livability is well established through the review of current literature. The livability principles are based on programs and practices that have been readily adopted and that are well known in the development world. The ability to quantify livability would be useful to communities not only for competitiveness for grant money, but also to provide the ability to identify shortcomings of a neighborhood, to identify the strengths of a neighborhood, and to rank neighborhoods based on a uniform quantitative measurement that is directly based on the livability definition established by the Partnership for Sustainable Communities.

A 2014 neighborhood-level study focused on identifying factors important to stakeholder perceptions of livability was conducted for the Memphis area (e.g., Wise, 2014). The primary goals of this research were to define livability from the residential stakeholder perspective, identify factors that are key contributors to livability, and to determine if variations in these factors could be linked to residents' ratings of livability for their neighborhoods. The information was collected through both focus group (to inform survey instrument design) and survey methodologies. The survey was distributed to residents around the Memphis area in both online and neighborhood meeting settings, and resulted in a total of 386 responses. The results of the study indicated that the residents included only peripheral links to transportation and community infrastructure in defining livability. The key element among all participants in the study that defined a livable community, regardless of the neighborhood in which they lived, was personal safety. The primary factors influencing residents' perceptions of

livability were: feeling safe in my neighborhood, knowing my neighbors, clean air and water, good roads, and living in an economically thriving neighborhood (e.g.,Wise, 2014). In addition, the work conducted by Wise resulted in a rating by participants of the livability of their neighborhoods. These findings serve as the basis for establishing criteria for the current research. The findings will also be used to compare results of the current project to establish how well quantification of the livability principles defined by the Partnership for Sustainable Communities aligns with residential stakeholder perceptions.

CHAPTER 3

METHODOLOGY

3.1 Methodology

The intention of this research is to develop a metric to quantitatively measure community livability that is tied to the 6 livability principles established by the Partnership for Sustainable Communities. This methodology is needed in order to provide communities with an approach for assessing current livability conditions and to identify which principle(s) need improvement to help prioritize approaches and funding of local projects in the hopes of improving overall community livability. In order to be not only successful but also broadly transferrable, any metric established for this purpose must meet the following criteria:

- Data are readily available by obtaining it from an existing source or through easily implemented data collection.
- The criteria are generalized enough to be applicable in different types of areas (rural, urban, and freight centric).
- The metric avoids counting indicators twice so that an indicator will be mutually exclusive to a principle. As seen in the case studies, an indicator could fit multiple principles. It is important that the indicators are not counted more than once because if an indicator were counted in two separate principles it would make that indicator have a larger weight on the overall livability score.

- The metric is applied at the neighborhood level, thereby reflecting community livability and allowing for the cohesion with the Wise 2014 study data results.
- Data and results are easily understood by a variety of stakeholders (community members, city planners, engineers, and legislative representatives).
- The metric is a direct translation of the key livability principles. The goal is not to define livability, since this was accomplished in the principles, but to measure the principles through a comprehensive and consistent set of indicators.

The approach developed in this research was applied to Memphis neighborhoods and validated using existing data from a previous research project. Each principle was individually investigated using either GIS or existing portals online. The total number of points available for each category is 20, resulting in an overall livability score of 100 possible points. The relative performance for the neighborhood in each category based on a selected indicator or set of indicators was used to reduce the score for a category based on the assessed discrepancies from ideal performance for each neighborhood. The methodology used to establish indicators for each principle is described in the following sections. For all principles, a Geographic Information System (GIS) is used to not only conduct the analysis, but to also visually display the assessment so that the evaluation is easier for all stakeholders to understand.

3.2 Measuring Principle 1

‘Provide more transportation choices’ is the first livability principle. The goal of this principle is to reduce the need on foreign oil, improve air quality, reduce greenhouse gas emissions, and promote public health (United States Department of Housing and Urban Development (HUD),U.S. Department of Transportation (DOT), and U.S. Environmental Protection Agency (EPA) 2013). Principle 1 will be quantified using the availability of other transportation modes other than a personal automobile. Reduction of vehicles on the roadway through mode shift will meet all of the listed goals above. The obvious one is the need for foreign oil. The reduction of vehicles on the road way will decrease congestion which leads to poor air quality due to greenhouse gas emissions. Other modes of transportation to replace personal vehicles are transit and bicycles. To measure how well the neighborhood currently addresses Principle 1, the indicators selected for this research were access to transit and bicycle facilities. The reasoning behind not addressing pedestrians in principle 1 is because this will be incorporated in another principle. Transit access was measured using a Geographic Information System (GIS). For the application in Memphis, TN, the service area for a transit stop was determined to be a quarter of a mile which is based on a standard value that has been determined from other research done throughout North America (Planning Commission TOD Committee n.d.). Using the buffer tool, a quarter of a mile buffer was placed around each transit stop. Each neighborhood was used as the boundary to clip the service area (quarter of a mile buffer) located around each stop. This was done all at once to eliminate

the overlap that could occur with stops being in close proximity to each other and provided a true service area for the neighborhood. Applying the analysis using the clip tool will capture the service area in each neighborhood. The score was determined for each neighborhood by comparing the total area to the transit access area, resulting in a percentage that was used to reduce the possible points for this indicator (10). The other indicator for principle 1 is bicycle facility availability. The roadway coverage of bicycle facilities was the second indicator for principle 1. The analysis was conducted by comparing the linear lengths of roadway facilities that are available for vehicles to the linear lengths of facilities available to bicycles. Each roadway length was determined by clipping the centerline within the neighborhood and determining the total length using the geometry calculator in GIS. Only existing (not proposed) bicycle facilities were incorporated into this analysis. The bike facilities in existence were clipped to determine the linear length of bicycle facilities in the neighborhood. The two lengths are compared by calculating a percentage. The percent coverage of transit and bicycle was then used to determine the total possible points (summing the two scores which were both out of 10) that principle 1 could receive which resulted in a score for a community's success in addressing the principle (total possible score is 20).

3.3 Measuring Principle 2

'Promote equitable, affordable housing' is the second livability principle. The goal of this principle is to increase mobility and lower the combined cost of housing and transportation for all. The DOT and HUD have developed a Location

Affordability Index (LAI) (U.S. Department of Transportation (DOT), U.S. Department of Housing and Urban Development (HUD), Sustainable Communities n.d.). This principle has already been quantified by the agencies and is available for the entire United States at the census block level. The LAI provides the estimation of the percentage of family income that is used on transportation and housing. The interactive map allows for the user to change the family size, income level, and the number of commuters (U.S. Department of Transportation (DOT), U.S. Department of Housing and Urban Development (HUD), Sustainable Communities n.d.). For the application to Memphis it was decided to leave the settings at default which is what is considered to be average which represents the median household income for that area, a four person family, and two commuters. Each neighborhood was examined by collecting all of the index numbers for the census blocks contained within a neighborhood and then the average value was determined. The values for each neighborhood did not contain enough variance to warrant the use of a median value. The census blocks that overlapped the neighborhood boundaries were addressed by using the value in the neighborhood that contained majority of the block. If in the rare occurrence the block landed in both evenly then the value was used in both of the neighborhoods. This value which is reported as percentage was used to reduce the total number of points available for this principle which was 20.

3.4 Measuring Principle 3

‘Enhance economic competitiveness’ is the third livability principle. The goal of this principle is to do this through access to employment centers,

educational opportunities, services and other basic needs. To quantify this principle the distance to employment or training centers, educational opportunities, medical facilities, and grocery and food stores was determined. The assumptions being made were that the educational opportunities are for adult education. The other important assumption is that the goal is to determine the distance to the option that is the closest. This removes the variability of choice, and it is recognized that this is a simplification to the assessment process and represents a limitation of the work. The goal is to determine the minimum distance a person would need to travel to reach an educational institute, an employment center, a medical facility, or a grocery store. The analysis conducted for Memphis converted each neighborhood, which is a polygon layer, into a point layer, with the point placed at the centroid of the polygon. To determine the distance to the closest educational or training center and the minimum distance to the closest educational institute a network was established using the roads layer. A network analysis was then conducted using the nearest parameter, resulting in the distance to the closest location of interest. The average commute distance to work that was reported by the FHWA for walking is 1.1 miles and for privately owned vehicle is 12.6 miles (U.S Department of Transportation Federal Highway Administration 2010). The minimum distance to a work location or a training/education location, medical facility, and grocery store was used along with these values to quantify principle 3. This is based off of adult pedestrians which is why the distance to work will be assumed to be the same for education. If the distance falls at or under the average for walking or driving, full points were

awarded to the category. If the distance does not then the category will receive a reduction by multiplying by the ratio of the distance and the appropriate distance.

3.5 Measuring Principle 4

'Support existing communities' is the fourth principle. The goal is to use federal funding to develop mixed-use development and land recycling along with the goal of increasing community revitalization. Mixed-use zones are new to the Memphis area even though the zoning type has been around for years. The goal of mixed-use is to gain more use of limited space and to limit urban sprawl by controlling growth (Community LIFT n.d.). To measure this it is important to identify how much of the land is already mixed-use. The percentage of area in each neighborhood that is zoned for mixed-use was determined using GIS and used as the indicator for current achievement of this principle. Although the highest score a principle can receive is 20 points it is not expected that a neighborhood will receive 20 points in this category, because a neighborhood will have many different kinds of zoning.

3.6 Measuring Principle 5

'Coordinate and leverage federal policies and investment' is the fifth principle. This principle is unique as it is on the government and policy level and has the goal to increase the accountability and effectiveness of all levels of government to plan for future growth. This principle is an action principle that has the goal of making livability a priority of those who are responsible for making policies and investments. This principle should be used to support the other principles. As needs are identified with the quantification of the principles,

planners and city officials can use this principle as a strategy for identifying funding sources and potential avenues through which partnerships can be developed to support community livability. As such, this principle is not included in the overall metric for assessing community livability.

3.7 Measuring Principle 6

'Value communities and neighborhoods' is the sixth principle. This principle's goal is to invest in healthy, safe, and walkable neighborhoods. The access to pedestrian facilities was investigated to quantify this principle. The principle was measured by identifying the availability of the pedestrian facilities in the neighborhood. The reason there is a focus on this mode and not the other modes, transit or bicycle, is because those modes are addressed in principle X. The percentage of roadways that contain sidewalks was analyzed to determine the extent of coverage for each neighborhood. The roadway centerline lengths for each neighborhood were doubled to account for the distance on both sides of the roadway. The percentage of the roadway that has sidewalk coverage was determined by clipping the sidewalk layer in GIS and comparing the length to the roadway length. The percent coverage was used to reduce the score for Principle 6.

3.8 Metric Development

The ability to measure how well each neighborhood addresses the principles will show where there is need for improvement. The goal of this research is not to define livability as that was already established through the six principles, but to develop a metric that can be applied to capture how well a

neighborhood addresses livability and to identify where the neighborhood may fall short. The 6 principles are not ranked in order of importance and there is no research that indicates one principle should be considered more important than another. Instead each principle is weighted equally. The metric includes only 5 of the 6 principles because principle 5 is not quantifiable and is rather an action principle that is used to establish a strategy for meeting the other principles. For this research, each principle was assigned a score of up to 20 points. For the principles that contain more than one indicator each indicator was weighted evenly, with all possible points for indicators summing to 20. The scale is arbitrary as long as each principle is weighted the same amount. Table 9 below outlines the scoring approach used in this research.

Table 9. Livability Metric

Principle	Indicator	Score
1	The percent coverage of transit service area (T)	
	Percent Coverage of Bike Facilities (B)	=10*T + 10*B
2	Affordability Index (A)	=20*A
3	Walking to Education (WE), Medical (WM), Employment (WJ), Food (WF)	Sum of ratios
	Driving to Education (DE), Medical (DM), Employment (DJ), Food (DF)	
4	Percent Mixed-Use land (M)	=20*M
6	Percent Sidewalk Coverage (S)	=20*S
	Livability Score	**=Sum of Column**

This metric was applied to the Memphis area. The city is home to one of the country's largest inland ports and the country's largest freight airport. It

contains a diverse population with 63.3% African American, 29.4% White, 6.5% Hispanic, and 1.6% Asian. It is also a more densely populated area than the rest of Tennessee, with 2,053.3 people per square mile versus Tennessee's average of 153.9 persons per square mile (US Census Bureau 2014). The diverse characteristics and the availability of residential survey data resulted in the selection of Memphis as the case study location. A score for livability was assigned to each neighborhood. The metric was then validated using residential surveys that were collected during a previous research project (cite unpublished livability report here).

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Results and Discussion

The metric developed through this research was applied to the Greater Memphis area neighborhoods. The Memphis neighborhoods from Clean Memphis and represents the neighborhoods of 2009 are shown in the map in Figure 1 below. Each neighborhood was analyzed individually. The following sections provide the results of the Memphis case study.

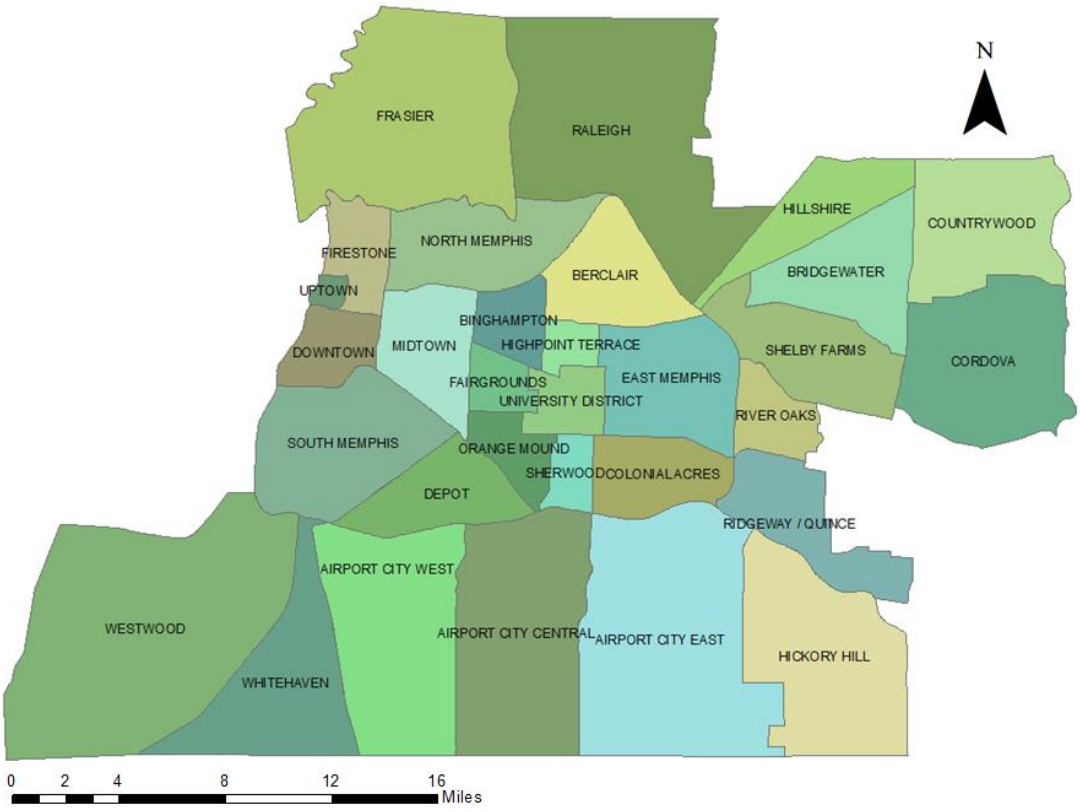

Figure 1. Memphis Neighborhoods (Clean Memphis 2009)

4.2 Principle 1 Analysis

The analysis for principle 1 included assess both transit access and bicycle lane coverage for each neighborhood in the study area. For the transit area assessment, the analysis was conducted taking into account that bus stops in adjoining neighborhoods could have coverage that overlapped into the neighborhood being analyzed and that this additional service area should also be considered. The total area of the neighborhood was calculated using GIS and was compared to the service area, which was delineated by a .25 mile radius buffer around transit stop locations. The 0.25 mile radius was selected based upon the standard walk distance to a transit stop. An example of transit stops in Memphis TN is shown in Figure 2.

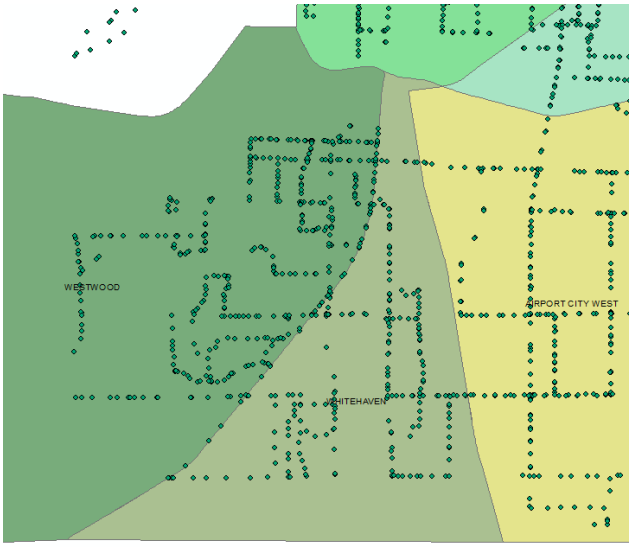

Figure 2. Bus Stops

The neighborhood boundary was used to clip the impact zone and the coverage area was compared to the total neighborhood area. The different types of existing bicycle facilities were next analyzed to determine the linear coverage for the second portion of principle 1 scoring. The linear coverage of bicycle facilities was compared to the linear distance of the roadway. The Figure below shows an example of the neighborhood boundaries and bicycle facilities.

Figure 3. Example of Existing Bike Facilities

To ensure that the weight of each principle was the same, the transit and bicycle modes were analyzed and each given a total possible score of 10 points each (resulting in a total possible score for the principle to be 20 points). This scoring for principle 1 could be adjusted to include additional modes of transportation if applicable for another area. The data in Table 10 below shows the score that the neighborhoods received for transit and bike facility coverage for principle 1.

Table 10. Principle 1 Transit Score

Neighborhood	Transit Coverage	Transit Score	Bike Coverage	Bike Score	Total Score
Downtown	99%	9.9	9%	0.9	10.8
Highpoint Terrace	98%	9.8	6%	0.6	10.4
Uptown	98%	9.8	7%	0.7	10.5
University District	92%	9.2	7%	0.7	9.9
Midtown	92%	9.2	10%	1.0	10.2
South Memphis	87%	8.7	3%	0.3	9.0
Depot	87%	8.7	3%	0.3	9.0
Fairgrounds	86%	8.6	6%	0.6	9.2
Binghampton	86%	8.6	3%	0.3	8.9
Orange Mound	84%	8.4	9%	0.9	9.3
Berclair	80%	8.0	7%	0.7	8.7
East Memphis	78%	7.8	7%	0.7	8.5
Colonial Acres	75%	7.5	6%	0.6	8.1
Firestone	73%	7.3	3%	0.3	7.6
Sherwood	72%	7.2	2%	0.2	7.4
Airport City West	70%	7.0	4%	0.4	7.4
North Memphis	68%	6.8	6%	0.6	7.4
Whitehaven	62%	6.2	2%	0.2	6.4
Airport City East	61%	6.1	4%	0.4	6.5
River Oaks	56%	5.6	7%	0.7	6.3
Airport City Central	49%	4.9	3%	0.3	5.2
Frasier	47%	4.7	9%	0.9	5.6
Ridgeway/Quince	46%	4.6	4%	0.4	5.0
Hickory Hill	46%	4.6	3%	0.3	4.9
Raleigh	39%	3.9	4%	0.4	4.3
Westwood	30%	3.0	5%	0.5	3.5
Hillshire	25%	2.5	6%	0.6	3.1
Bridgewater	21%	2.1	5%	0.5	2.6

Neighborhood	Transit Coverage	Transit Score	Bike Coverage	Bike Score	Total Score
Countrywood	14%	1.4	2%	0.2	1.6
Cordova	4%	0.4	5%	0.5	0.9
Average		**6.4**		**0.5**	**6.9**
Standard Deviation		**2.6**		**0.2**	**2.7**

The transit score is out of 10 maximum points has a standard deviation of 2.6 and a mean value of 6.4. The data has a large range of values with a minimum value of 0.4 and a maximum value of 9.9. Figure 4 presents the transit score for the neighborhoods in the study area.

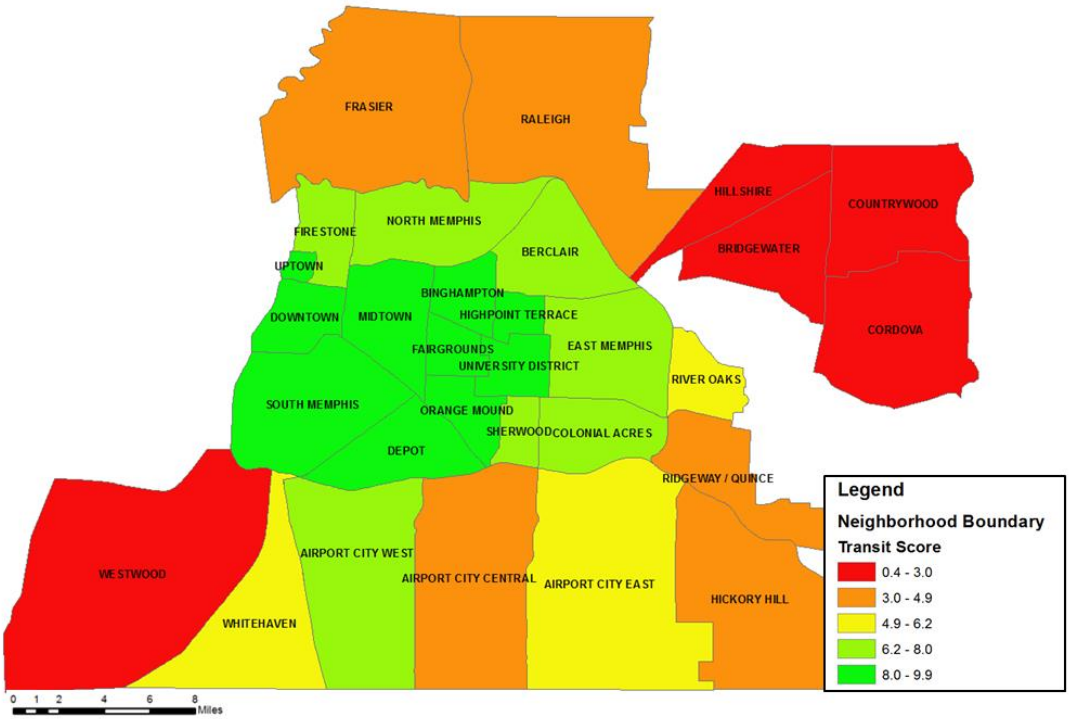

Figure 4. Transit Score

Transit works well in urban settings so it would be expected that the scores for the transit portion of principle 1 would decrease as the neighborhoods move farther away from the city. The farther away the neighborhoods move from the city the less dense the population becomes and the land use changes, making it less advantageous from a logistical view to invest in transit coverage. The expected scoring pattern is observed in Figure 4, where the highest coverage (indicated in green) is seen in the central Memphis area, with scores decreasing along the outer edges of the city.

Figure 5 shows the bike facility scores for Memphis area neighborhoods. To consider a bicycle a good mode choice, at the minimum, the user needs to have a facility available to them that provides a sense of security. For bicycles on urban streets, this generally corresponds to a designated (and preferably dedicated) bike lane due to the higher traffic volumes and speeds present on these corridors. The results in Table 10 are mapped below and represent the percentage of the total linear miles of the roadway network that incorporates a bicycle facility within each neighborhood boundary.

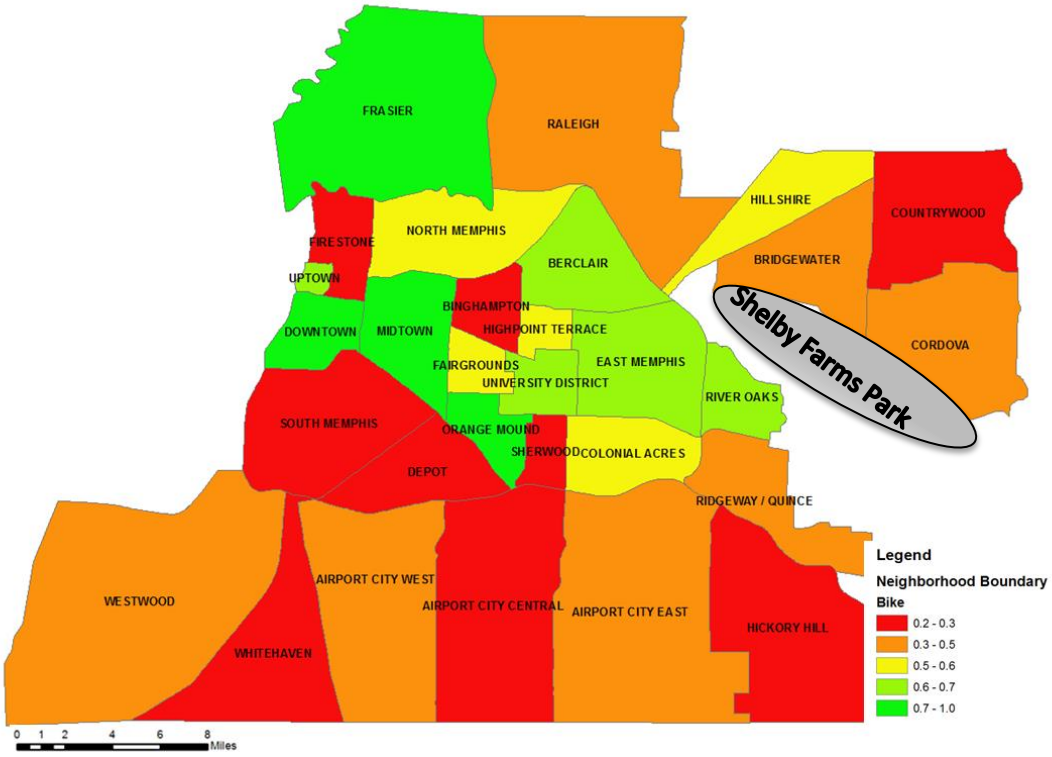

Figure 5. Bike Facilities

The average bike score for Memphis area neighborhoods is 0.5 with a standard deviation of 0.2. The analysis resulted in a limited range of scores when assessing this principle, and all scores were quite low. This result is expected and is due to the limited extent of bicycle facilities in Memphis, as a concerted effort to provide bicycle lanes and delineated routes has only been pursued by the city in the last few years. As the city's network continues to expand, it is anticipated that many neighborhoods will be rated much higher for this portion of principle one. The variation across the city that is seen in bicycle coverage scores follows appropriate trends. For example, south of Bridgewater and north of River Oaks is the location of a large park that contains a significant number of bicycle paths. In addition, many of the facilities in Memphis lead to Shelby Farms

Park which explains the higher scores to the west of the park and in the Hillshire neighborhood. The bulk of the City of Memphis bicycle facility investment has occurred within the central portion of the city, and is evident by the green shading prevalent in this area. One outlier is the Binghamton neighborhood. This community is scheduled to receive additional bicycle facilities in the near future, but because of the environment compared to the surrounding neighborhoods it did not receive precedent. There is a large amount of freight facilities which increases the amount of heavy vehicles on the roadway. The roadways contained in the neighborhood are interstates and high volume roadways which are not conducive for the safety of bicycle facilities.

The small range and low score for bicycle facilities have a large negative impact on the score for principle 1 and the overall livability score. Further research is needed to determine if the two modes, transit and bicycle, should be weighted the same on the scoring metric, as the percentage of the population reasonably expected to use each mode and resident's expectations for bicycle and transit access may not be accurately captured. It may also be appropriate to consider a network distance from each residence in a neighborhood to an accessible bicycle facility, as distance to such facilities is likely to impact the decision to use this mode in much the same way as it does for transit. It is important as well to recognize that in the Memphis area the concept of installing bicycle facilities around the city and county is fairly new and so it is growing and as a result there are not very many existing bicycle facilities.

4.3 Principle 2 Analysis

Analysis for principle 2 utilized the Affordability Index available to the general public located on the Location Affordability Portal developed by the HUD and DOT (U.S. Department of Transportation (DOT), U.S. Department of Housing and Urban Development (HUD), Sustainable Communities n.d.). The averages for each neighborhood are shown in Table 11 below. The total score earned for the principle for each neighborhood was calculated by multiplying the total possible score of 20 points by the percentage assigned through the affordability score, also shown in Table 11.

Table 11. Principle 2 Affordability Index

Neighborhood	Affordability Index	Principle Score
RiverOak	65%	13.0
East Memphis	62%	12.4
Ridgeway Quince	60%	12.0
Cordova	60%	12.0
Countrywood	58%	11.7
Hickory Hill	57%	11.4
Whitehaven	56%	11.2
Colonial Acres	56%	11.2
Hillshire	56%	11.2
High Point Terrace	56%	11.1
Fairgrounds	55%	10.9
University District	54%	10.9
Airport City East	54%	10.8
Westwood	54%	10.7
Raleigh	53%	10.7
Frasier	53%	10.7
Berclair	53%	10.6
Airport City Central	53%	10.5
Bridgewater	52%	10.5
Sherwood	51%	10.2
Airport City West	51%	10.2
South Memphis	51%	10.2
Midtown	51%	10.1
Depot	51%	10.1

Neighborhood	Affordability Index	Principle Score
Orange Mound	50%	10.1
Binghampton	50%	9.90
North Memphis	49%	9.80
Firestone	49%	9.80
Uptown	48%	9.70
Downtown	44%	8.70
Average		**10.70**
Standard Deviation		**0.90**

A review of the scores indicates there is little variability across Memphis area neighborhoods, due to a fairly tight range (44 to 65 percent) on the Affordability Index ratings for the area. The mean score for principle 2 for the Memphis area is 10.7, with a standard deviation of 0.9 points. The principle 2 scores range from low of 8.7 to a high of 13.0 points. Figure 6 below displays the scores spatially.

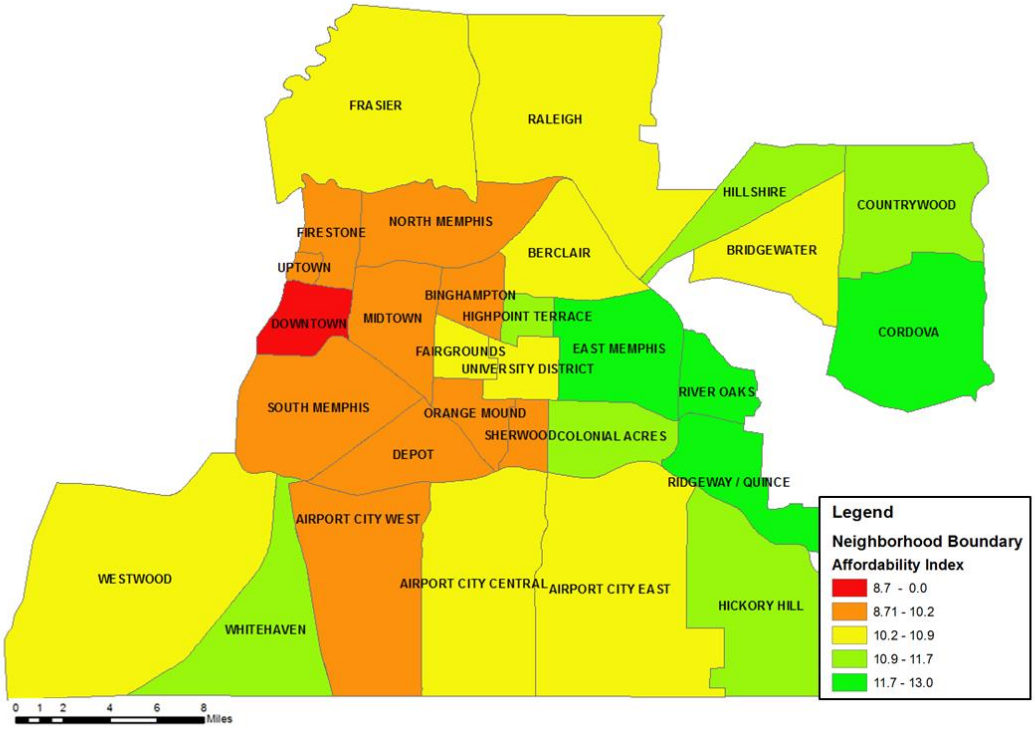

Figure 6. Principle 2

The Affordability Index is determined using a ratio of median household income to the cost of housing and transportation. Examining the spatial trends shows a general pattern of decreasing Affordability Index in the western-central portion of the Memphis area, with the index increasing in the neighborhoods further from the downtown/midtown portion of the community. The Downtown neighborhood area received the lowest affordability score of all Memphis neighborhoods. This is a prime location to live because of the proximity to the downtown entertainment areas. Living in this area of Memphis would be advantageous for proximity to work for the jobs in the central business district, education and entertainment, and would be expected to result in a lower estimate for transportation cost because of proximity to attractions and access to multi-modal

transportation options. However, the prime location also results in significantly higher housing costs in this area. The Downtown neighborhood has a very skewed median income profile, with high income areas located on the western boundary, and the bulk of the neighborhood consisting of lower-income residents. The median household income for each neighborhood is shown in the figure below (ESRI 2010).

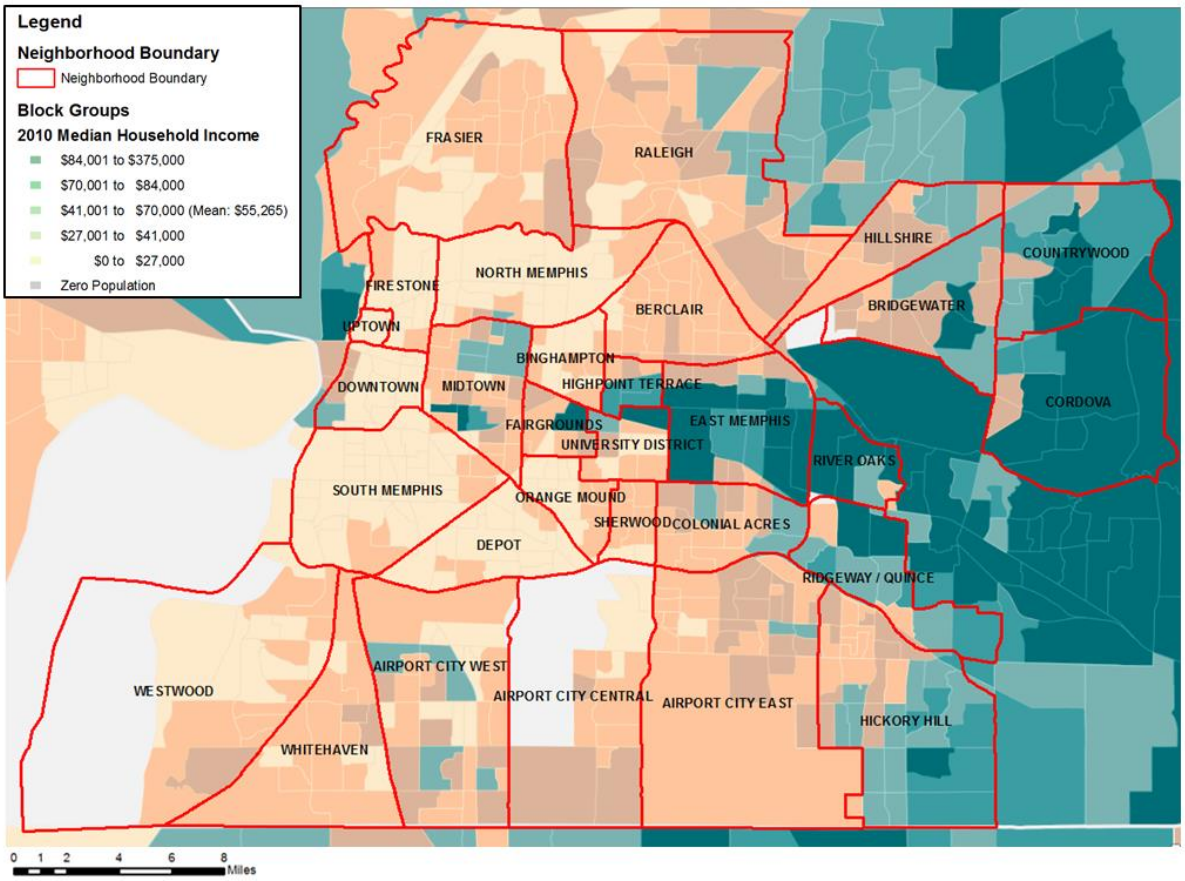

Figure 7. 2010 Median Household Income (ESRI 2010)

The results from this study show the affordability index increasing as the neighborhood move away from the city. Although the cost of transportation would

increase as residents move away from the city the median household income also increases (shown in Figure 7) and the cost of housing decreases, resulting in an offset and increasing the relative affordability.

4.4 Principle 3 Analysis

In order to determine the scoring for principle 3, the distance to the closest facility for each 'need' category (education, medical, job, food) was calculated. The analysis was conducted using the Network Analysis tool pack in GIS, using the Memphis roadway network. The locations of the job centers and the location of education and training facilities along with health and food facilities were used as the destination point for the analyses. Each neighborhood was transformed from a polygon to a point layer by determining the centroid of each neighborhood polygon. The network analysis was run for each neighborhood to determine the minimum distance to an education/training facility, job center, medical facility, and grocery or food market. The minimum values were then used to determine if the distance was within the FHWA established walking threshold of 1.1 miles and the driving threshold of 12.6 miles. Each neighborhood was analyzed using walking to study, driving to study, walking to work, driving to work, walking to medical, driving to medical, walking to food, and driving to food. Each of the eight categories was worth a total of 2.5 points and the total number of points for this principle was determined by summing these, resulting in a maximum value of 20. Tables 12 & 13 below display the Principle 3 analysis results.

Table 12. Principle 3 Analysis A

Neighborhood	Walk to Study	Drive to Study	Walk to Work	Drive to Work
Airport City Central	2.50	2.50	0.84	2.50
Airport City East	2.34	2.50	1.05	2.50
Airport City West	2.50	2.50	1.17	2.50
Berclair	2.36	2.50	1.77	2.50
Bing Hampton	2.50	2.50	2.30	2.50
Bridgewater	1.71	2.50	1.18	2.50
Colonial Acres	2.50	2.50	1.87	2.50
Cordova	1.22	2.50	0.68	2.50
Countrywood	1.34	2.50	0.92	2.50
Depot	2.50	2.50	1.74	2.50
Downtown	2.50	2.50	2.50	2.50
East Memphis	2.50	2.50	2.14	2.50
Fairgrounds	2.50	2.50	2.50	2.50
Firestone	2.36	2.50	1.96	2.50
Frasier	0.79	2.50	1.15	2.50
Hickory Hill	1.36	2.50	0.64	2.50
High Point Terrace	2.76	2.50	2.50	2.50
Hillshire	2.50	2.50	2.50	2.50
Midtown	2.50	2.50	2.50	2.50
North Memphis	2.26	2.50	1.30	2.50
Orange Mound	1.67	2.50	2.33	2.50
Raleigh	2.50	2.50	0.85	2.50
Ridgeway/Quince	2.43	2.50	1.18	2.50
RiverOak	2.50	2.50	2.08	2.50
Sherwood	1.17	2.50	1.85	2.50
South Memphis	2.04	2.50	2.10	2.50
University District	2.50	2.50	2.50	2.50
Uptown	2.50	2.50	2.50	2.50
Westwood	0.58	2.50	0.70	2.50
Whitehaven	0.95	2.50	1.31	2.50
Average	**2.08**	**2.50**	**1.69**	**2.50**
Standard Deviation	**0.62**	**0**	**0.66**	**0.00**

Table 13. Principle 3 Analysis B

Neighborhood	Walk to Medical	Drive to Medical	Walk to Food	Drive to Food	Total Score
Airport City Central	0.80	2.50	1.87	2.50	16.01
Airport City East	1.35	2.50	1.10	2.50	15.84
Airport City West	2.50	2.50	2.50	2.50	18.67
Berclair	0.60	2.50	2.31	2.50	17.03
Bing Hampton	0.90	2.50	1.30	2.50	17.00
Bridgwater	0.79	2.50	1.07	2.50	14.75
Colonial Acres	1.02	2.50	2.50	2.50	17.89
Cordova	0.59	2.50	0.68	2.50	13.18
Countrywood	0.77	2.50	1.19	2.50	14.22
Depot	1.04	2.50	1.37	2.50	16.65
Downtown	2.50	2.50	2.50	2.50	20.00
East Memphis	1.11	2.50	2.50	2.50	18.26
Fairgrounds	2.10	2.50	1.60	2.50	18.70
Firestone	1.75	2.50	1.20	2.50	17.27
Fraiser	0.48	2.50	0.51	2.50	12.93
Hickory Hill	0.62	2.50	1.26	2.50	13.88
High Point Terrace	0.71	2.50	2.50	2.50	18.47
Hillshire	1.28	2.50	2.35	2.50	18.64
Midtown	2.50	2.50	2.50	2.50	20.00
North Memphis	0.74	2.50	0.77	2.50	15.08
Orange Mound	2.38	2.50	2.08	2.50	18.47
Raleigh	1.25	2.50	2.50	2.50	17.10
Ridgeway/Quince	1.05	2.50	2.50	2.50	17.15
RiverOak	2.27	2.50	0.84	2.50	17.69
Sherwood	1.21	2.50	2.50	2.50	16.72
South Memphis	1.35	2.50	1.56	2.50	17.04
University District	1.07	2.50	2.50	2.50	18.57
Uptown	2.50	2.50	1.67	2.50	19.17
Westwood	0.44	2.50	0.46	2.50	12.17
Whitehaven	1.05	2.50	1.10	2.50	14.40
Average	**1.29**	**2.50**	**1.71**	**2.50**	**16.77**
Standard Deviation	**0.67**	**0.00**	**0.71**	**0.00**	**2.07**

The standard deviation of driving to all ‘need’ facility types is zero, as expected, for all Memphis neighborhoods because in the Memphis urban area setting, all

residents live within the threshold provided by FHWA as a reasonable driving distance to all category types. Figure 8 below shows the overall scores for principle 3.

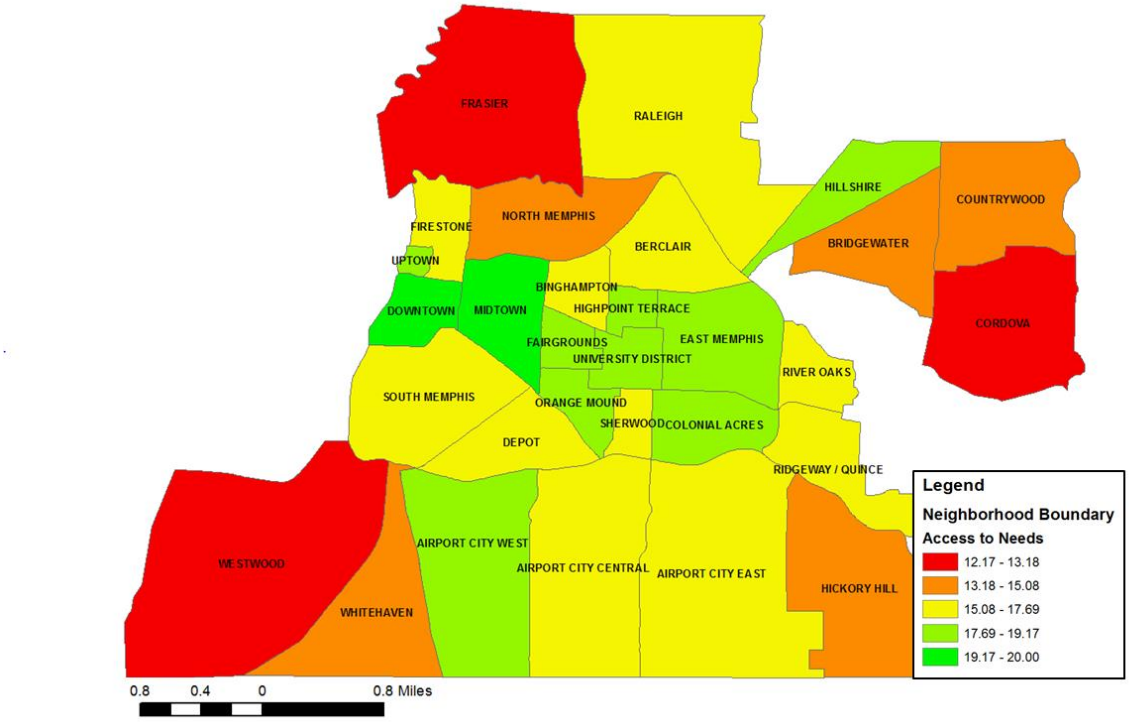

Figure 8. Accessibility to Needs Score

In general, the farther away from the city center, the lower the 'accessibility to needs' score. The three neighborhoods that scored the lowest are Frasier, Westwood, and Cordova. The Downtown and Midtown neighborhoods have the highest score. The walk score controlled the overall 'accessibility to needs' score suggesting that the density of needs is much higher in the Downtown and Midtown neighborhoods. This would be expected in an urban setting. The ability to walk to a need is considered an important aspect of accessibility, but as the

location changes from urban to a more suburban setting (Cordova) the accessibility decreases. This principle is favorable of urban settings and does not rank non-urban settings highly, which may produce skewed results when analyzing the overall livability score if applied to diverse settings. The application to a variety of settings (urban, suburban, rural) should be investigated further to determine if different indicators or different weights should be given to indicators based on the surroundings, particularly given the expectations of stakeholders (residents) in less urbanized environments.

4.5 Principle 4 Analysis

The percentage of the land use that is mixed-use was used to determine the score assigned for principle 4. The total area of land use for each neighborhood was compared to the area of land use that is designated as mixed-use. Mixed-use is defined as any development that mixes residential, commercial, and industrial. Each neighborhood contains many different types of land uses, but many have limited mixed-use development, which reduces the overall score for livability principle 4. The percentage of mixed use development was determined using ArcGIS for each neighborhood and is displayed in Table 14 below.

Table 14. Principle 4 Mixed-Use Land

Neighborhood	Mixed-Use Land Coverage	Principle Score
Airport City Central	42%	8.4
Sherwood	23%	4.6
Fairgrounds	23%	4.5
Orange Mound	21%	4.1
Depot	19%	3.8
Downtown	17%	3.4

Neighborhood	Mixed-Use Land Coverage	Principle Score
Binghampton	15%	3.0
South Memphis	14%	2.8
East Memphis	14%	2.7
Firestone	13%	2.5
Midtown	13%	2.5
Berclair	12%	2.3
North Memphis	10%	2.0
Hillshire	10%	2.0
Hickory Hill	10%	2.0
Bridgewater	10%	1.9
Countrywood	10%	1.9
Frasier	9%	1.9
Airport City West	9%	1.9
Airport City East	9%	1.9
Raleigh	9%	1.9
Cordova	9%	1.7
Westwood	9%	1.7
Whitehaven	8%	1.7
Uptown	4%	0.9
Colonial Acres	0%	0.0
Highpoint Terrace	0%	0.0
Ridgeway/Quince	0%	0.0
River Oaks	0%	0.0
University District	0%	0.0
Average		**2.3**
Standard Deviation		**1.7**

The mean score for this principle is 2.3 out of a possible 20 points. The low scores determined through this assessment are an identified weakness of the current metric, as there are many locations of a city that may not have a high percentage of mixed-use development, but may be considered highly livable by residential stakeholders. One possible approach to address this limitation is additional data collection regarding percent mixed-use land coverage around many different cities nationwide to determine what an appropriate percentage for mixed land use in a community for livability purposes would be. Developing a

threshold for an appropriate range in relation to other land use categories could allow for the value to be weighted differently. In the results for this research, the Airport City Central neighborhood scored very high, but this is the location of the Memphis International Airport that is also the location of the FedEx Hub (2nd largest cargo airport in the world). This unique land use has resulted in shipment companies and residents that work at these locations moving closer to the airport for convenience and has resulted in the presence of mixed use development. However, the high rating for this principle is not necessarily aligned with the livability experience of neighborhood residents, as this is also one of the neighborhoods plagued by lower income, higher crime, and fewer bicycle and pedestrian facilities. The figure below shows the mixed land use distribution around the city.

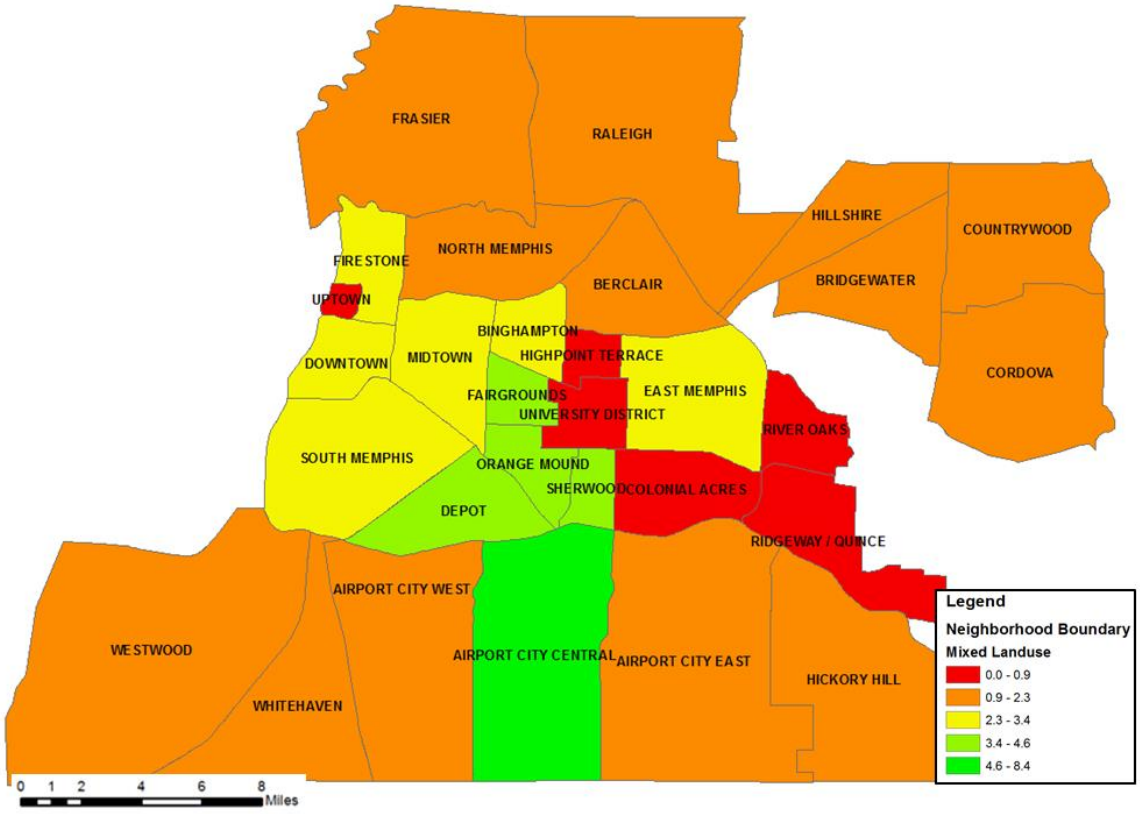

Figure 9. Mixed Land Use

The score for principle 4 decreases the further the neighborhood is from the airport, which would suggest that large industrial, warehousing and logistics companies that provide services and supply jobs drive the development of mixed use land. The same inference can be made with the neighborhoods on the opposite end of the spectrum. These neighborhoods (such as University District and River Oaks) are predominately residential, and are some of the most prominent neighborhoods in the city. While not mixed use, it is unlikely that residents of these neighborhoods would rate livability low for their communities. This is another principle that is potentially biased to urban settings, and additional

research should be conducted to determine whether or not a metric should allow for parameters to be weighted differently between urban and non-urban settings.

4.6 Principle 6 Analysis

Principle 5 was not analyzed because previous discussion indicated that it should not be quantified and is a supportive principle for the other principles. The measurement of principle 6 was based on the walkability of the neighborhood. The goal was to determine the percentage of the roadway that contained sidewalks. For the analysis, which used the length of the roadway centerlines as a comparison base, required the length of the centerline to be doubled to account for two sides of the roadway. The reason for this was to account for both sides of the roadway containing a sidewalk which would provide pedestrians with a safe location to walk. Table 15 below shows the score for the principle.

Table 15. Principle 6 Sidewalk Coverage

Neighborhood	Sidewalk Coverage	Principle Score
Airport City Central	41%	8.3
Airport City East	52%	10.4
Airport City West	26%	5.2
Berclair	81%	16.2
Binghampton	80%	16.0
Bridgewater	24%	4.8
Colonial Acres	78%	15.6
Cordova	30%	6.0
Countrywood	45%	9.0
Depot	56%	11.1
Downtown	63%	12.6
East Memphis	68%	13.6
Fairgrounds	51%	10.2
Firestone	67%	13.4
Frasier	57%	11.4
Hickory Hill	40%	8.0
Highpoint Terrace	77%	15.4

Neighborhood	Sidewalk Coverage	Principle Score
Hillshire	52%	10.3
Midtown	80%	16.0
North Memphis	69%	13.7
Orange Mound	84%	16.7
Raleigh	32%	6.5
Ridgeway/Quince	43%	8.6
River Oaks	30%	6.0
Sherwood	78%	15.6
South Memphis	64%	12.7
University District	70%	14.0
Uptown	60%	12.1
Westwood	42%	8.5
Whitehaven	30%	6.0
Average		**11.1**
Standard Deviation		**3.7**

The mean score for this principle is 11.1, with a standard deviation of 3.7 points, indicating a fair amount of variability in the resulting scores. The minimum value is 6 and the maximum value is 16.7. The results are displayed in Figure 10 below.

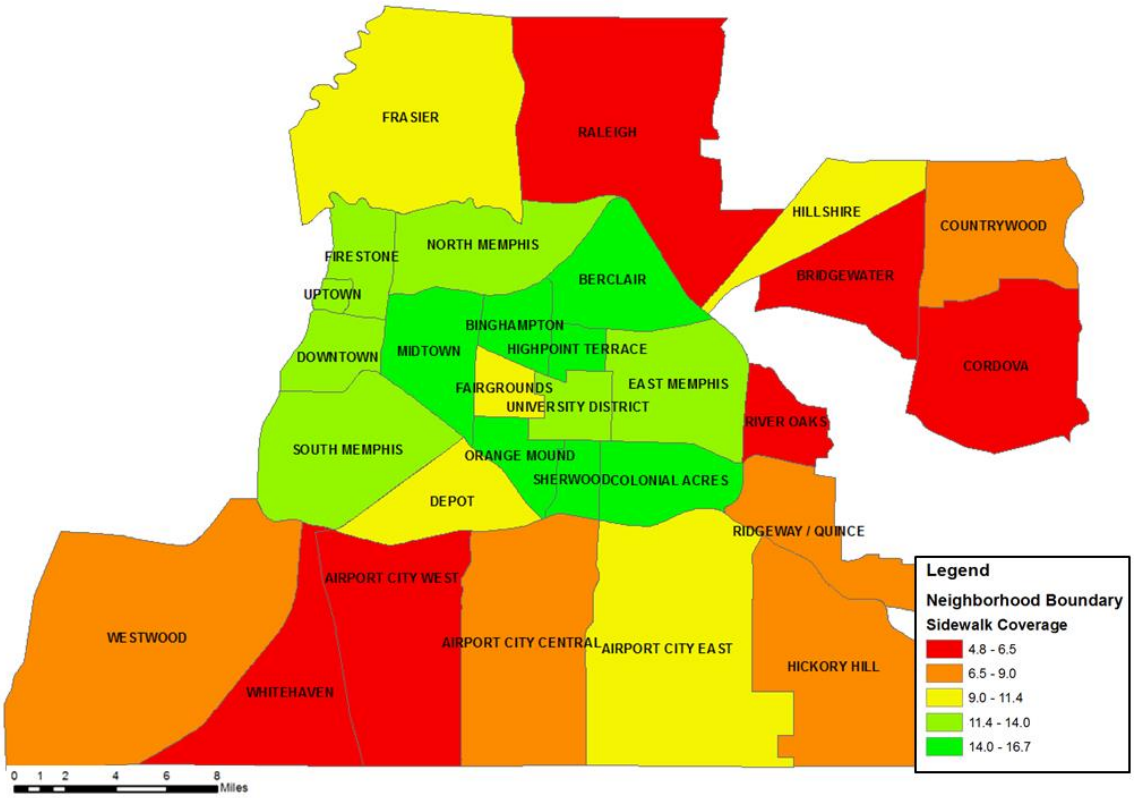

Figure 10. Sidewalk Coverage

There are many different observations to be made from the score distribution for this principle. The central portion of the Memphis area scores the highest for this principle. This is also the portion of the city that was built well before the outskirt areas, and was generally established with good connectivity resulting from shorter block lengths, a grid network, and sidewalk coverage in all neighborhoods. As the city began to expand beyond this central area, development occurred in a pattern more representative of urban sprawl, with more cul-de-sac development, less connectivity, and fewer sidewalks being constructed. Figure 11 below displays a walkscore that represents how likely people are to use walking as an alternative mode of transportation and was determined considering intersection density, residential density and the amount

of retail in the area (Mid-South Regional Greenprint Geoportal n.d.). This analysis shows a pattern similar to that established through simple sidewalk coverage analysis for assessing principle 6, where the central portion of the city predominantly contains the highest scoring areas. The primary difference between the two is in the fact that the walkscore assessment was conducted at the block level, and thus reveals heterogeneity within the neighborhood.

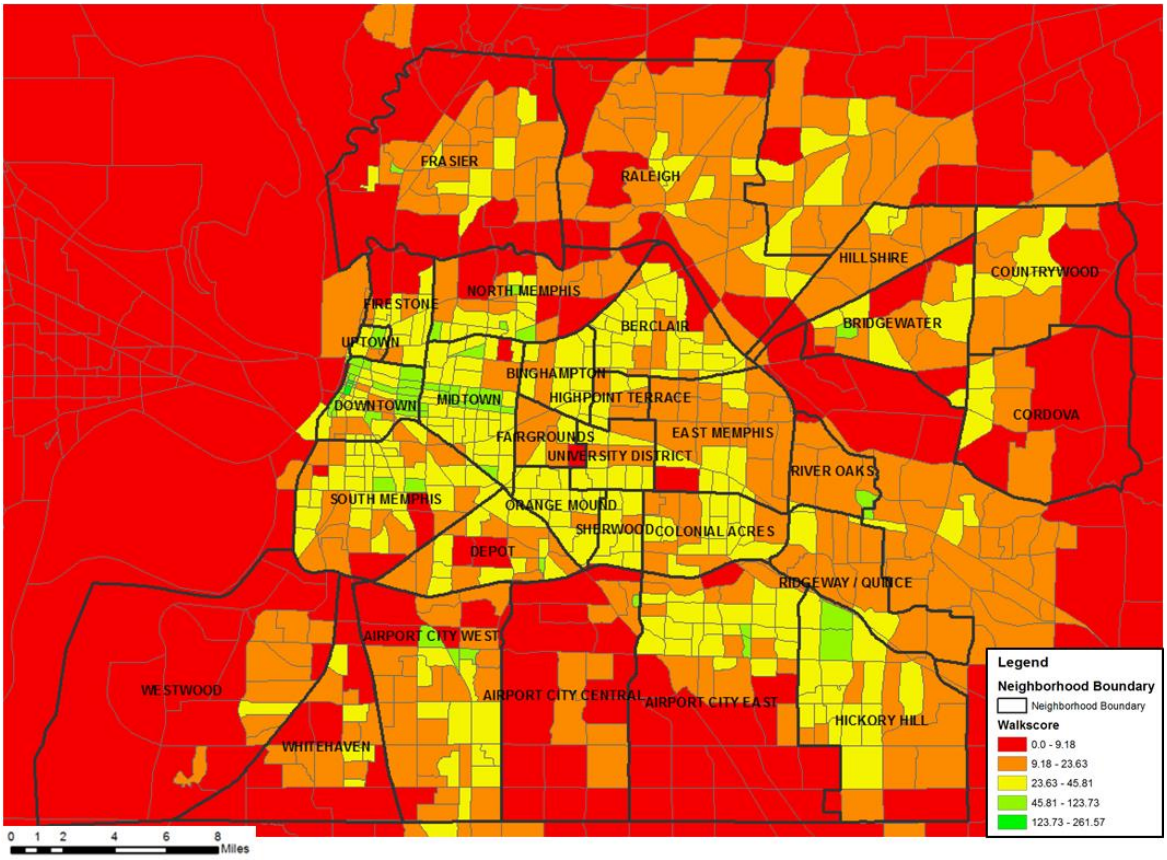

Figure 11. Walkscore (Mid-South Regional Greenprint Geoportal n.d.)

Thus, the likelihood that someone would walk is directly related to the sidewalk coverage in the neighborhood for the current project assessment. This again is

another example of the low score that nonurban areas receive with the principle because of the lack of facilities, which is likely due to the limited number of attractions and more homogenous land use in nonurban settings.

4.7 Final Score

After evaluating each individual principle, the principle scores for each neighborhood were then summed to provide the neighborhood with an overall livability score based on the six livability principles established by the Partnership for Sustainable Communities. The Table 16 below shows the result of the investigation.

Table 16. Total Livability Score

Principle	1	2	3	4	6	Livability Score
Neighborhood						
Airport City Central	5.2	10.5	16.0	8.4	8.3	48.4
Airport City East	6.5	10.8	15.8	1.9	10.4	45.4
Airport City West	7.4	10.2	18.7	1.9	5.2	43.3
Berclair	8.7	10.6	17.0	2.3	16.2	54.8
Binghampton	8.9	9.9	17.0	3.0	16.0	54.8
Bridgewater	2.6	10.5	14.8	1.9	4.8	34.6
Clonial Acres	8.1	11.2	17.9	0.0	15.6	52.9
Cordova	0.9	12.0	13.2	1.7	6.0	33.8
Countrywood	1.6	11.7	14.2	1.9	9.0	38.4
Depot	9.0	10.1	16.6	3.8	11.1	50.7
Downtown	10.8	8.7	20.0	3.4	12.6	55.6
East Memphis	8.5	12.4	18.3	2.7	13.6	55.5
Fairgrounds	9.2	10.9	18.7	4.5	10.2	53.6
Firestone	7.6	9.8	17.3	2.5	13.4	50.5
Frasier	5.6	10.7	12.9	1.9	11.4	42.4
Hickory Hill	4.9	11.4	13.9	2.0	8.0	40.2
Highpoint Terrace	10.4	11.1	18.5	0.0	15.4	55.4
Hillshire	3.1	11.2	18.6	2.0	10.3	45.2
Midtown	10.2	10.1	20.0	2.5	16.0	58.8
North Memphis	7.4	9.8	15.1	2.0	13.7	48.0
Orange Mound	9.3	10.1	18.5	4.1	16.7	58.7

Principle	1	2	3	4	6	Livability Score
Raleigh	4.3	10.7	17.1	1.9	6.5	40.5
Ridgeway/Quince	5.0	12.0	17.2	0.0	8.6	42.7
River Oaks	6.3	13.0	17.7	0.0	6.0	43.0
Sherwood	7.4	10.2	16.7	4.6	15.6	54.6
South Memphis	9.0	10.2	17.0	2.8	12.7	51.7
University District	9.9	10.9	18.6	0.0	14.0	53.3
Uptown	10.5	9.7	19.2	0.9	12.1	52.2
Westwood	3.5	10.7	12.2	1.7	8.5	36.5
Whitehaven	6.4	11.2	14.4	1.7	6.0	39.7

The scores were then mapped using to show the differences in livability scoring (Figure 12).

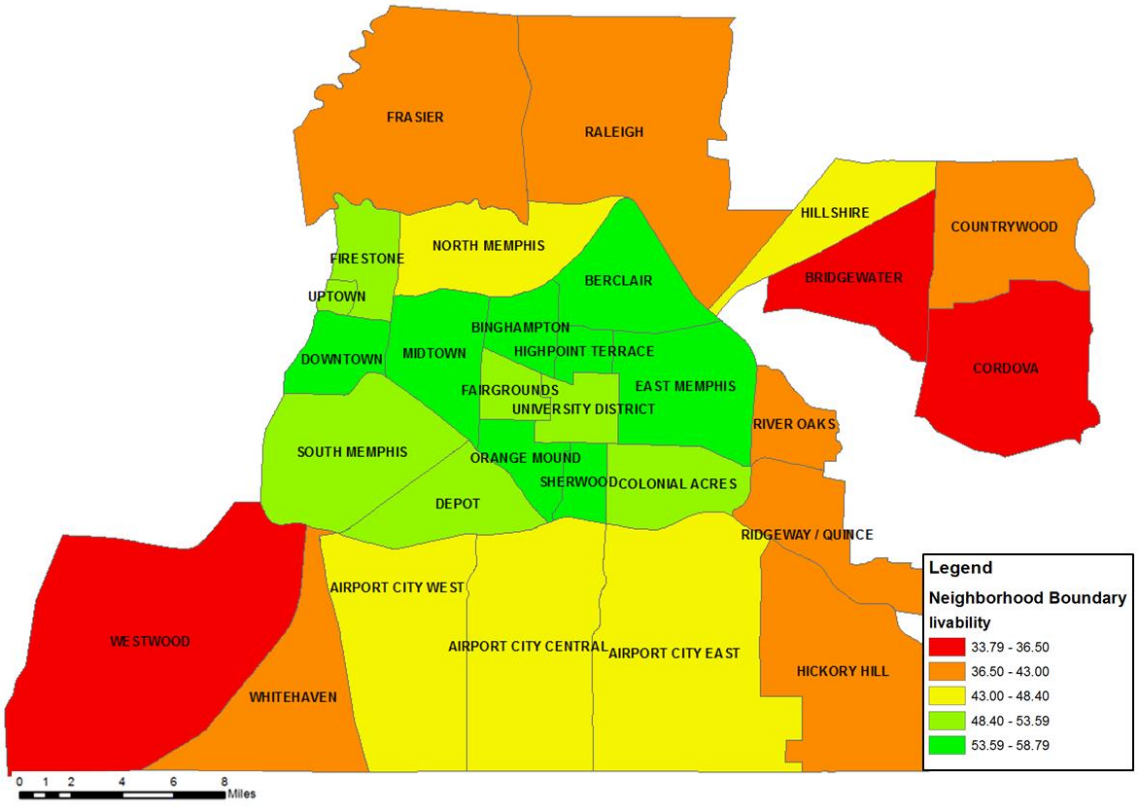

Figure 12. Livability Score

The overall results reveal the same pattern as the individual livability principles, with the closer proximity to the city center resulting in a higher livability score. Westwood scored very low because the majority of the neighborhood is agricultural, and lacks the infrastructure for multimodal transportation options and the land use diversity. Cordova and Bridgewater are both separated from the city by the large park discussed previously that is located south of Bridgewater. This could be a contributor of the low score along with the area being more similar to a suburb setting than urban. Most of the infrastructure investment for bicycle facilities and sidewalks has been in the central portion of the city, so this also accounts for the lower ratings in the suburban areas when considered in conjunction with lengthier travel times to attractions. Another consideration regarding the scoring is whether or not changing the subdivision level might result in different scores. In some cases, neighborhoods cover much larger areas than in others, and this may result in a somewhat biased score if the neighborhood contains very different types of land use and infrastructure. For instance, one half of the neighborhood might receive a high score and another half a low score if they were considered separately. Together, the effect is averaged and may not appropriately reflect livability conditions for the entire neighborhood. An example of this is Westwood. When looking at the neighborhood there is a small proportion of the neighborhood that actually contains areas that are inhabited. Majority of the neighborhood is agriculture and when using the total area as a comparison to the measured indicator the results are low. This is an identified weakness of the research, but the importance of

conducted this at the neighborhood level is important because the available validating data is at that level.

The next step in the research process was to attempt to validate the metric with residential survey data obtained in 2014 from residents of the city of Memphis through a project focused on community livability. The purpose of this step was to determine if the metric developed for the current project was capturing the same livability measurements that the community stakeholders reported. The table below reports the measured livability score (the score derived from this research which has been scaled down by to be comparable) and the survey livability score (the average score from the residential survey collected in 2014 research for each neighborhood (e.g., Wise, 2014).

Table 17. Comparison to Survey

Neighborhood	Measured Score	Survey Score	Survey Number (N)
Airport City Central	4.8	5.0	5
Airport City East	4.5	6.2	25
Airport City West	4.3	7.6	11
Berclair	5.5	6.8	8
Binghampton	5.5	7.3	3
Bridgewater	3.5	6.7	3
Colonial Acres	5.3	8.0	6
Cordova	3.4	8.4	5
Countrywood	3.8	8.3	7
Depot	5.1	7.0	1
Downtown	5.6	6.8	5
East Memphis	5.5	8.8	6
Fairgrounds	5.4	7.5	2
Firestone	5.0	No Survey	0
Frasier	4.2	5.4	8
Hickory Hill	4.0	6.8	15
Highpoint Terrace	5.5	10.0	10
Hillshire	4.5	7.3	3

Neighborhood	Measured Score	Survey Score	Survey Number (N)
Midtown	5.9	7.5	16
North Memphis	4.8	8.0	8
Orange Mound	5.9	5.5	2
Raleigh	4.0	6.3	8
Ridgeway/Quince	4.3	8.1	8
River Oaks	4.3	8.0	8
Sherwood	5.5	No Survey	0
South Memphis	5.2	6.0	6
University District	5.3	7.5	4
Uptown	5.2	8.0	1
Westwood	3.7	No Survey	0
Whitehaven	4.0	9.0	3

A statistical analysis was conducted to determine if the two distributions of scores were statistically different. The data from the research in 2014 was collected using a Likert scale and as a result is ordinal data. This required the use of a non-parametric test. The Wilcoxon Signed Rank Test was used and produced a two-tailed *p* value of 0.0. Since the *p* value is less than 0.05 it suggests that the data is significantly different. This result indicates that the current metric is not aligning with the stakeholders (residents of the neighborhoods) perception. In every neighborhood the stakeholders rank the livability higher than the metric score. Although there were very small samples for each neighborhood from the survey data, additional research needs to be conducted to better align the metric with stakeholder perceptions.

CHAPTER 5

CONCLUSTION and RECOMMENDATIONS

5.1 Conclusion and Recommendations

The metric developed through this research scored the neighborhoods in Memphis, TN on the principles developed by the Partnership for Sustainable Communities. Principles 1, 2, 3, 4, and 6 were assigned indicators that represented the priorities of the principles and met the study requirements. The study requirements, established so that the measurement process resulting from the work could be useful to a broad spectrum of communities and stakeholders, were as follows: the principles should be able to be applied at the neighborhood level; the data used should be easily accessible; the indicators should be directly representative of the livability principles; and the indicators and results should be easy to understand for a variety of stakeholders (engineers, city officials, and community members). The 5th principle was not quantified because it has the goal of supporting the other principles with policies and funding. The results of the livability metric applied to the City of Memphis neighborhoods for this research are statistically different from results of a previous study reporting how stakeholders perceive the livability of these same neighborhoods. The number of surveys available for each neighborhood in Memphis is low, so this may be a contributing factor in the apparent differences. However, the 2014 stakeholder survey found that the contributor of livability that ranked the highest was feeling safe in the neighborhood (e.g., Wise 2014). The contributors to livability used in the 2014 study are presented in Table 18 below, along with the percentage of

people (n=386) who ranked the contributor as one of the most important factors for livable communities. The final column of the table indicates whether or not the contributor relates to the livability principles established by the Partnership for Sustainable Communities.

Table 18. Stakeholders Survey (e.g., Wise, 2014)

Contributors of Livability	Percentage who Ranked it the Most Important	Principle Addressed
Feeling safe in my neighborhood	87%	N
Knowing my neighbors	43%	N
Clean Air and Water	42%	N
Good roads	41%	N
Living in an economically thriving neighborhood	39%	N
Minimal road congestion	38%	N
Having a sense of community	35%	N
Living close to school/work	33%	Y
Having a say in what happens in my neighborhood	30%	N
Quality affordable housing	30%	Y
Having a park in my neighborhood	26%	N
Living near a hospital	22%	Y
Having a community center	21%	N
Having alternative transportation options (walk, bike, public transit)	19%	Y
Public art and/or landscaping	16%	N
Good bus service	10%	Y

Based upon this data, it is apparent that there is a discrepancy between the established livability principles and the values of community residents related to livability. One very important indicator that is not included in the livability principles is the safety within the neighborhood. Publicly available crime data for neighborhoods could be used to establish a metric for assessing this aspect.

The reoccurring pattern that was apparent on every principle for the current research was that as the distance to the city center increases, the livability ranking decreases. This indicates that the established livability principles may be biased toward urban locations. Residents of suburban and rural communities may not perceive a reduction in quality of life based upon factors measured by the livability principles; thus it may be appropriate to develop a strategy for assessing diverse communities in different ways or by comparing to differing thresholds.

5.2 Recommendations for Future Research

This research identified numerous areas that should be considered for future research. Addressing these issues would lead to a much more robust assessment of community livability. Additionally, this would enable a metric to be developed that may be more broadly applicable and transferable across communities. The following are the primary recommendations resulting from this work:

- More surveys of residential stakeholders should be collected to ensure that the livability rating assigned to a neighborhood is truly reflective of residents' opinions to strengthen the analysis in the Memphis area;
- Additional research should be conducted to determine if there should be development of different livability principles based on the environment being studied: urban, sub-urban, and rural. If consistent principles are to be used across settings, consideration should be given to establishing

different measures, weights or thresholds for comparison for each principle based upon community setting;

- A national-level project should be conducted using both the livability metric and residential stakeholder surveys to determine whether or not the approach is transferrable; and
- Additional research is needed to bridge the apparent gap between residential perspectives and established livability principles. For instance, the inclusion of personal safety which was identified as a primary concern of residential stakeholders in the Wise study is one modification that should be considered within the definitions of the livability principles. This alignment is important to ensure that policies and funding are used to improve community livability reflecting needs of the stakeholders.
- The exploration into a block level to highlight the areas with in the neighborhood that are impacting the overall score. This research was intended to be done on the neighborhood level to provide cohesion with previous research done in the Memphis TN area.

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