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Examining Pedestrian Accessibility to Opportunities in Four New Deal Villages

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EXAMINING PEDESTRIAN ACCESSIBILITY TO OPPORTUNITIES IN FOUR NEW DEAL VILLAGES

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DEDICATION

To Dr. Luis Ramos,

This terminal project is dedicated to you, who have always been my guide and support to reach this point. Your dedication and passion as a professor are admirable and I never forget your help and belief in my abilities. Your feedback and encouragements were a driving force to my success, and I am grateful that I had the chance to work under your supervision and grow as a student soon to be part of the planning field.

Thank you for your patience, wisdom, and unwavering support without which this project has not been possible. I am forever grateful for all that you have done for me.

1. CHAPTER ONE

1.1. INTRODUCTION

This study focuses on *accessibility* as an essential performance factor in city planning and urban development**.** The automobile-oriented designs that characterize and organize most modern United States cities, since the 1950s, have degraded pedestrian mobility and accessibility, causing people to be largely dependent on cars rather than walk, bike, and/or use public transit to reach essential and complementary daily destinations. This pervasive condition not only hinders community and sense of place, but also negatively affects people's health and environment. We as planners should not forget that cities should be designed to serve people rather than cars. The more our cities are pedestrian accessible, the more they will draw people in, and potentially bring about other positive qualities, like safety, that could result in a better place to live in.

This study explores how pedestrian accessibility to key destinations might be influenced by: 1-land-use spatial structure and 2- urban design, using transportation network topology as proxy. As a case study, the study compares the pedestrian accessibility afforded by four *New Deal villages* (Greenbelt (MD), Greendale (WI), Greenhills (OH), and Eleanor Roosevelt (P.R.)). These towns, or *villages* as they were originally conceived, were planned, and developed during the late 1930s as part of a comprehensive Federal economic revitalization policy program known as the *New Deal* (Figure 1).

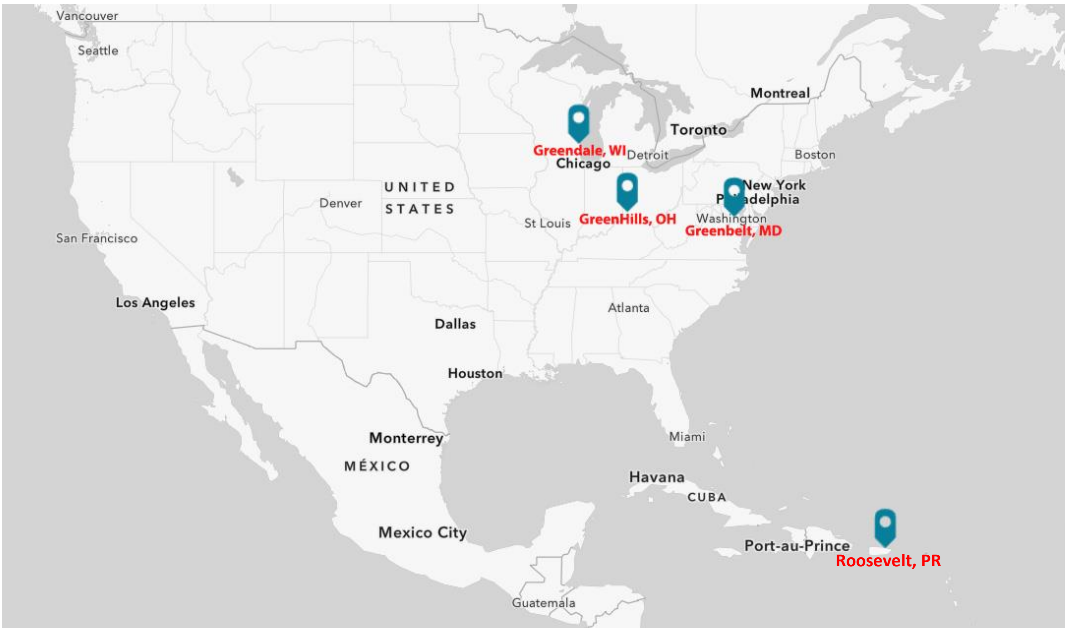

Figure 1: Geographic location of four *New Deal villages* in the United States and Puerto Rico, Source: ArcGIS Pro open street map

All four *New Deal villages* cases share the same age; similar mix of architectural typologies and densities; and similar original land-use programming where most services and opportunities for socio-economic interactions were located at and near a village center. Yet, these case studies differ slightly, with one of them differing significantly in terms of urban design and transportation network layout. These villages present a convenient quasi-experimental framework to evaluate how urban design, as expressed in the scaling and design of neighborhood blocks and in the disposition of their transportation networks (pedestrian and vehicular) might influence levels of accessibility to opportunities in each village and possibly corresponding aggregate travel behavior.

Results from this investigation could inform recommendations to improve pedestrian accessibility in lower-ranking neighborhoods, according to the calculations and analysis of this study brought in the table of result (page 39) as well as inform methodologies and best-practices for the planning, design, and assessment of pedestrian accessibility in other existing or proposed neighborhoods.

Sampling strategy motivated the selection of the four New Deal Town cases in this investigation and relates to their common policy and ideological (communitarian) origins, overarching planning, and spatial design paradigms inspired by Howard's Garden City Model, which emphasized self-sufficiency and pedestrian accessibility; similar socio-economy profile and purpose as communities geared for the working class and lower-income families; and all being publicly subsidized in pursuit of housing affordability and job creation in a time of economic crisis.

Despite all the similarities, only Eleonor Roosevelt Village exhibits a traditional web-like grid street network, in contrast to the larger and more organic superblock morphology of the other three *New Deal villages* located in the US mainland that reflect a distinct suburban neighborhood design tradition influenced by Clarence Stein and Henry Wright's Radburn development, in New Jersey.

Comparing these four neighborhoods could provide me insight into the influence of urban design and land-use patterns on pedestrian accessibility as a key factor in the planning and design for more sustainable neighborhood patterns that promote more walking. The insights and methods explored in this terminal project could also inform assessment protocols to evaluate existing and future developments as a standard practice in city planning, management of the built environment, and urban design.

2. CHAPTER TWO: LITERATURE REVIEW

2.1. GUIDING RESEARCH QUESTIONS

Q.1 What is accessibility, in general; and pedestrian accessibility in particular? and what role could it play in city planning and urban design?

Q.2 How does the built environment and street network design influence accessibility to neighborhood destinations on foot (walkability)?

Q.3 How can pedestrian-based accessibility be measured and be used in evaluating existing and new neighborhoods for policy and design recommendations?

2.2. LITERATURE REVIEW

Many residential areas in United States which were constructed after 1950 lack a continuous, well-connected streets network design such as traditional orthogonal grid formats. They are instead based mostly on cul-de-sac and loop patterns with large block sizes that limit route choice and an accessible distribution of activities. To minimize the construction costs, these streets tend to be over-sized and often lack sidewalks (Southworth and Ben-Joseph 2003, 2004).

According to Forsyth & Southworth, 2008, the lack of walkable cities has been a problem in US cities for decades, and despite the efforts of urban designers, there was not much success in most locations. In recent years, however, new laws; governmental incentives; and pedestrian and bicyclist activism have begun to alter the situation for the better.

Pedestrian-oriented development is needed to achieve more sustainable cities. As noted by Forsyth and Southworth (2008)

> "Walking is a 'green' mode of transport that reduces congestion and has a low environmental impact, conserving energy without air and noise pollution. It can be more than a purely utilitarian mode of travel for trips to work, school, or shopping and can have both social and recreational value".

Providing good pedestrian infrastructure, most people of different ages can enjoy walking while it is free of charge and, therefore, a socially equitable mode of transport. Also, the advantages of walking on people's mental and physical health are undeniable, promoting cardiovascular fitness, reducing stress, and causing stronger bones, mental alertness, and creativity (Forsyth and Southworth, 2008).

All the reasons mentioned above inform the importance and relevance of an investigation focused on walkability and pedestrian accessibility in the exercise of city planning and urban design. This Terminal Project (T.P.) will focus, in general, on the topic of 'accessibility' as a city-planning and urban-design performance indicator. And more specifically, on pedestrian accessibility to crucial neighborhood destinations (a.k.a. opportunities, jobs, retail, health services, food (supermarkets), pharmacy, school, etc.).

In using this approach, it is necessary to document and assess both the neighborhood transportation network design (which is a key element of urban design); and the land-use structure of the neighborhood (e.g., mix and location of different land-uses; commercial, residential, mixed, industrial, civic, among others). These two dimensions of the build-environment can influence and result in varying levels of 'accessibility'.

In addition, another primary concern in this investigation is defining and identifying different ways to quantitatively measure accessibility on foot at the neighborhood level as an emergent phenomenon that results from these multiple interacting factors. Thus, a review of definitions of accessibility from geography, urban design, and city planning disciplines and ways to measure it is included in this literature review.

2.3. Key Concepts and Definitions

Pedestrian

"A pedestrian is a person traveling on foot, whether walking or running. In modern times, the term usually refers to someone walking on a road or pavement, but this was not the case historically".

https://en.wikipedia.org/wiki/Pedestrian

"A pedestrian is any person walking, standing, or in a wheelchair".

Wisconsin Department of Transportation, 2002

Pedestrian Accessibility and Walkability

Walkability is the possibility provided by the built environment to support and encourage walking. It can be influenced by qualities such as pedestrian comfort and safety, good connection between varied destinations within a reasonable amount of time and effort, and visual interest in journeys throughout the network (Southworth, 2005).

A well-connected street network design can increase walkability, providing access to the common destinations people visit daily. It also supports pedestrians' safety and comfort by easy-to-cross streets for different ages with different degrees of mobility. Landscape elements, trees, and other visual connections are effectively used to attract people and create an engaging environment.

> "The pedestrian network links seamlessly, without interruptions and hazards, with other transit modes such as buses, trams, or subways, minimizing automobile dependence. The path system is sufficiently complex to explode over time, offering varied visual experiences with repeated encounters. It supports walking for practical purposes, such as shopping or the journey to work, as well as for pleasure, recreation, and health. Thus, pedestrian proximity to nearby locations (opportunities) is a critical factor."
>
> (Southworth, 2005)

Walkability

Literature seems to indicate that distance is the most influential factor in people's decision on whether walk or take the car (or other modes) to their destinations. Other factors mentioned as also to be taken into account are weather, physical difficulty, safety, or fear of crime, although these are less of a determinant (Funihashi, 1985; Komanoff and Roelofs, 1993; Handy, 1996; Smith and Butcher, 1994).

The average distance that Americans will walk on a daily basis is about 400 mts (¼ miles) which is quite limited (Weinstein, 1996). This approximately equals to 5 to 10 minutes distance to their destinations for doing their errands. However, there are other factors such as the quality of the path network (Jaskiewicz, 2001) that also affect walking as a chosen mode of travel.

According to Southworth and Berkeley (2005) a path should be more than just access between opportunities; by improving some qualities of the path network, the likelihood of walking can be increased. Those qualities are:

1. Connectivity of path network, both locally and in the larger urban setting.
2. Linkage with other modes: bus, streetcar, subway, train.
3. Fine-grained and varied land use patterns, especially for local serving uses.
4. Safety, both from traffic and social crime.
5. Quality of path, including width, paving, landscaping, signing, and lighting; and

6. Path context, including street design, visual interest in the built environment, transparency, spatial definition, landscape, and overall exploitability."

(Michael Southworth, UC Berkeley, 2005).

2.4. Urban Design Perspectives on Walkable Cities have and How to Measure It?

Several methods for assessing and measuring pedestrian behavior can be found in the urban design, transportation, health sciences, and city planning literature. For example, *space syntax* is used in reports on individuals' walking behavior (e.g., travel diaries). Another way to examine the impacts of urban design features is remote sensing and GIS. It has been used to study multi-use urban greenway trails and design features. Other researchers' study and consider contextual factors such as presence of light rail stations, environmental factors, and/or other visual perceptions that may influence pedestrians' route choice. (Forsyth & Southworth, 2008)

2.4.1. Accessibility

Accessibility means the ability to access, measuring potential opportunities for interaction. It considers the ease of reaching destinations or activities rather than the ease of traveling along the road (El-Geneidy, Levinson, 2006). An origin and a destination combined with potential activity at the destination and travel time, or cost are the main parts of any accessibility measure (Koenig, 1980).

In addition to the attributes mentioned above, we should be aware of some indirect factors when measuring accessibility. First, we should consider *where* access is being measured and how many destination opportunities can be reached. Secondly, some *impedances*, such as time, distance, money cost, and other travel-related expenses, reduce access. The next factor is the time of travel. Access to opportunities depends on *when* people travel. For instance, access during peak hours differs from that at 4:00 am. Apart from that, some opportunities(destinations), like restaurants, provide services at specific times, making people choose certain places at a specific time of day.

Another factor is the *reason* for travel (i.e., trip purpose) and the type of opportunities people are interested in engaging, such as jobs, houses, stores, among others. Because some jobs are not available at the same time (e.g., some provide services during the morning while some are available during the evening and night) accessibility to similar activities might also vary by time of day and/or weekdays and weekend.

Furthermore, we should consider *for whom* we are measuring accessibility as it can be defined differently for children, elders, and the disabled. The final factor is *Lifecycle Access*, which means that access continues over many years rather than occurring simultaneously. So, long-time decisions should be made about it (Levinson, Wu H., 2020).

2.4.2. Measures

The literature on accessibility measures identifies several methods such as infrastructure-based accessibility measures; location-based accessibility measures; person-based accessibility measures; utility-based accessibility measures, among others.

Two of the most used methods are cumulative opportunity measures and gravity-based measures, with the latter being more complex in calculations and having some weaknesses (El-Geneidy & Levinson, 2008). Of particular interest and relevance in my study, which focuses on accessibility to local opportunities by foot, is the location-based cumulative-opportunities measure.

It counts the number of opportunities that can be reached within a given travel time, distance, or cost (fixed costs), or measure of the (average or total) time or cost required to access a fixed number of opportunities (fixed opportunities)" (Geurs and Van Wee, 2004). Another way to define it is provided by the Journal of Health Geographic (Philippe, et. al., 2017):

> *"… the number of services within n meters or minutes, or, in other words, to the availability provided by the immediate surroundings".*
>
> (Philippe et al., 2017).

In sum, a cumulative opportunity measure is a simple and useful way to calculate the number of opportunities, and services within an immediate environment. The total 'cost' of reaching opportunities, whether based on time or distance, is result of the transportation network layout (~ urban design) and the location of opportunities relative to that network.

According to Levinson and Wu H., (2020) cumulative opportunities can be calculated through the following formula:

$$Ai = \sum_{j=1}^{j} \mathrm{Oj}(\mathrm{cj})$$

Where:

A_i: access from the centroid of census tract (or other geographical unit, e.g., neighborhood center)

O_j: number of opportunities available at destination j

C_i: cost of travel from i to j (travel time or distance)

Potential Contributions

Observations and insights from this research could inform local planners and urban designers on the development of pedestrian accessibility measures to assess and compare current levels of accessibility and to assess potential neighborhood layouts and designs as part of daily administrative/permitting evaluations; policy development; and identify possible street network design and/or key destinations spatial distribution for pedestrian accessibility improvements.

2.5. How Has Cumulative-Opportunities Measures Been Used in Previous Pedestrian Accessibility Studies

Various studies have taken advantage of cumulative opportunity measure to assess pedestrian accessibility. One is "Access to Destinations: Development of Accessibility Measures" by El-Geneidy and Levinson (2006). These authors measured the pedestrian accessibility in the Twin Cities region in Minnesota using a ***contour*** cumulative opportunity measure to count the number of opportunities within a desired distance/time for pedestrians. The formula is:

$$A_i = \sum_{j=1}^{J} B_j \, a_j$$

A_i = Accessibility measured at point *i* to potential activities (a.k.a. Opportunities) in zone *j*

a_j = Opportunities in zone *j*

B_j = A binary value equals to 1 if zone *j* is within the predetermined threshold and 0 otherwise (El-Geneidy & Levinson, 2006)

This measure can be used for counting the number of different opportunities within a specific distance/time without measuring the costs of travel or attractions. For pedestrian access, only the opportunities within 400 meters away are valuable.

However, according to the type of opportunities, their importance can vary considerably. For example, life supporting opportunities such as supermarkets and hospitals do not have equal value to opportunities like sports, parks, and bus stops. To give more appropriate value to different opportunities based on their importance, the authors used a weighing sum measure framed within multimodal accessibility matrix. This is captured in a table that registers different types of opportunities and rank them according to people's preferences based on the mode of transport. (El-Geneidy & Levinson, 2006).

Table 1: Accessibility Matrix

	jobs	schools	parks	shopping
Automobile				
Transit				
Bicycling				
Walking				

Source: Ahmed M. El-Geneidy & David M. Levinson, 2006

To assess the level of accessibility of the four *New Deal villages*, we need to calculate the cumulative opportunity measure for each land use and each neighborhood separately and then weight the opportunities according to their importance. Finally, I will rank and compare the cases and discuss. The weighting scheme for destinations that I will be using in my study was developed by myself and my advisor and includes classification of opportunities according to their importance, similar to the classification defined and used by Zheng et al, 2019, listed below:

C.1 Life supporting Activities (Opportunities): Supermarket (food), Medical Services (pharmacy; generalist, hospital), Number of Jobs.

C.2 Life Development Opportunities: Schools.

C.3 Health Supporting Activities: Parks, Gymnasiums, Sport Court/Facilities.

C.4 Life Enriching Activities: Social Clubs, Shopping Opportunities

C.5 Access to Metropolitan Opportunities: Num. of Bus Stops, Transit Stops, etc...

A higher value will be assigned to C.1, and lower values as they go down C.2, C.3, C.4 (values: C.1=2.0; C.2=1.0; C.3=0.5, ...etc. (Zheng et al, 2019)

3. CHAPTER THREE: RESEARCH DESIGN AND METHODS

3.1. Research Design

My research design is framed as a 'comparative multiple-case study' based on four cases of *New Deal villages*. These are Greenbelt (MD), Greendale (WI), Greenhills (OH), and Eleanor Roosevelt (P.R.). Data and insights were contrasted in a comparative framework that sought commonalities and differences. The project principally focuses on a quantitative measure of pedestrian accessibility to opportunities located at village centers.

Understanding how the neighborhood street network (transportation) and/or land-use structure might have influenced the pedestrian accessibility levels would provide guidance for city planners in designing and devising policies for more walkable, more accessible, and thus more livable and sustainable neighborhoods.

Case Sampling Strategy

The 'sampling strategy' for my multiple-case study was based on 'purposeful' theoretical sampling; more specifically 'an operational construct sampling' based on real-world examples of 4 *New Deal villages* cases, one of which is considered a *revelatory* case (Eleonor Roosevelt Town) that displays a distinct street network design.

The reason why these four cases were chosen has to do with their similarities, including aspiration of self-sufficiency and pedestrian accessibility that guided their urban design; all being publicly planned, designed, subsidized and constructed in the year 1936 as part of a governmental plan for providing affordable housing and creating jobs. In addition, they were all geared to a similar socio-economic demographic, population size, and underpinning collaborative political economy. However, it is only Eleonor Roosevelt Town that has a traditional grid shape street network. This divergence in urban design and street network helps frame this study and sheds light on current debates related to the potential influence of the built environment, via urban design, on travel behavior.

3.2. Method

In this project accessibility by foot will was evaluated for each village with a weighted contour-based cumulative opportunity measure. Pedestrian service areas and location and description of activities (e.g., opportunities) were processed in a GIS platform (ArcGIS Pro) and a custom project geodatabase was curated and developed. The weights are drawn from a study conducted by Zheng et al. (2019).

Data

The development and calculation of a weighted contour-based cumulative opportunities accessibility measure requires the number of opportunities that can be reached within a travel time or distance in each village, and an activity description for classification of each activity type (a.k.a. points of interest; POIs). It also requires the transportation network design for pedestrian ways to produce the pedestrian service area (a.k.a. Pedshed). Both types of data are required in digital format and/or implementation and in GIS.

Additional socio-economic, jobs, and aggregate travel behavior data was accessed via secondary sources using US census. These helped in establishing correlations between pedestrian accessibility levels and aggregate travel patterns for each village. Specifically, the analysis focused on travel to work (commute) by foot due to data limitations.

Other parcel-level data sourced from the Urban Footprint platform; and ArcGIS-Pro v2.9 databases related to the following class of information was integrated and processed in a new GIS geodatabase for the study:

1. **Vector-feature** Street network (street segments + nodes [intersection]) for pedestrian-only trails and streets with sidewalks).

    - Source: OSM base map in ArcGIS Pro via Clemson University license

2. **Point-feature** shapefiles and/or geodatabases of key destinations (opportunities), such as schools, supermarkets, hospitals, pharmacies, jobs, parks, transit stops, shopping, etc.

- Sources: Point-of-Interest (POIs) ArcGIS FourSquare database; UrbanFootprint (Parcel-level); poifactory (http://www.poi-factory.com/); Google Street View

3. **Demographic + Socioeconomic** shapefiles or geodatabases (e.g., population, jobs, HH median income, and commute travel behavior by mode).

- Sources: ArcGIS Pro Atlas database; US ACS 2020 Census

GIS Protocol for Calculating the Weighted Contour Pedestrian Cumulative Opportunities Indicator.

Step 1: A new project geodatabase in ArcGIS Pro was created to organize and process the project data. With the help of my adviser, the 5 minute pedestrian service area was calculated for each village, georeferencing and using the theoretical village center as the location for analysis using ArcGIS Pro 'Network Analyst' tool for network-based service area delineation. The digital multimodal transportation network facilitated by ArcGIS via Clemson University license was critical in this step of the study.

Step 2: Point-of interest (POI) data sourced from 'Four Square', was downloaded and integrated. This was also obtained avia a Clemson University license with ESRI ArcGIS. All POI classification available for each village were downloaded and a sample of n=10 was verified for each village in Google Street View for quality assurance. For Elanor Roosevelt village several POIs were missing, and these were georeferenced using Google Street

View. Some other POIs were also added from the POI factory (http://www.poi-factory.com/) to complete the missing POIs for Roosevelt and then, layers from all those three sources were joined as one layer using the standard 'FourSquare' classification system.

Step 3: The FourSquare category website was used to understand meaning of each category code in order to be able to differentiate the activity types. Weights were added as another attribute andw each POI as given a specific standardized weight according to the Zheng et al. (2019) classification of activities.

Step 4: The weighted sum for the weight column for each village was calculated using the ArcGIS Pro summary statistics function.

Step 5: As a way to validate the accessibility instrument used in this study, the https://www.walkscore.com/ website was used to get the WalkScore for each village. WalkScore is a similar walkability indicator, yet as a proprietary source it does not share its weighting scale and thus is less transparent. Furthermore, the percentage of people commuting by car, walk, public transportation, and bicycle to go to their work was obtained from US Census ACS data for year 2020. These measures help validate the pedestrian accessibility instrument developed in this study and identify any correlation with travel behavior.

Step 6: Number of jobs located within each village center was obtained using year 2020 US Census 'OnTheMap' point-features data to register the number of employments in each village as a factor affecting commute and accessibility.

Step 7: Finally, the US Census block-level population of each village within the pedestrian service area was also calculated using ArcGIS Pro 'Summarize Within' tool to examine the supply-demand relationship between population and the opportunities provided at local-level.

3.3. Analytical Strategy for Comparison of Cases

After registering and georeferencing all the different opportunities (e.g., jobs, schools, grocery stores, shops, etc.) located at each village center, including those missed in the FourSquare database, the *weighted sum score* was used to rank neighborhoods from the one that provides the most accessibility on foot, to the least accessible. Also, the resulting ranking was compared to WalkScore values and Commute walking mode share as validation of the accessibility measure. The formula used to calculate the weighted cumulative opportunities sum is:

$$A_i \text{wsm} - \text{score} = \sum_{j=1}^{n} \left(w_j * a_{ij} \right) \;\; for\ i = 1,2,3, \ldots$$

Where:

A_i = accessibility score by walking at village service area i

j = opportunity (activity)

a = activity type

w = weight by activity type

Assessment of accessibility levels for each of the four cases and comparison relied on the weighted contour cumulative opportunities score A_i, described next.

Aw modified version of the ***contour*** cumulative opportunities model as then used to measure and compare the levels of pedestrian accessibility of each neighborhood; rank the villages according to this indicator; and identified those with a lower level of pedestrian accessibility to make recommendations (whether on the transportation and/or land-use dimensions) to improve accessibility. The modification consisted in the application of a new weighting matrix (w^a) based on activity types (e.g., visiting doctor, shopping retail, visiting friends, etc.) drawn from a study by Zheng et al. (2019). This more nuanced measure of accessibility accounts for a hierarchy of human needs derived from Manslow (1943) seminal paper on human needs (Figure 2). This is proposed as a more valid operationalization of accessibility than simply counting the number of activities in the villages. Each opportunity identified in each village was matched and classified according to Zheng et al. (2019), classification of activities and with the associated standardized weighting factor w^a that the authors obtained via regression analysis. The final equation for the modified contour model is then:

$$A_i = \sum_{j=1}^{J} B_j \, (a_j * w^a)$$

Where B_j is a binary value equal to 1 if zone j is within the predetermined pedestrian threshold and 0 otherwise. I gave a specific weight to each opportunity according to the standardized values provided by Zheng et al.2019.

Table 2: Relative importance, trip shares and weighting factor per activity type, Source: Lijuan Zheng, 2019

Human Needs	**Life Domains**		**Activity types**		**Further modification factors: emergency, social values and policy preferences**	**Standardized Weighting Factors**
	Life domains	Relative importance to quality of life1	Activity types	Share in trips (%)[1]		
The Fundamental Need	Financial status or job	0.15	Work	25.5	n.a.[2]	0.317
			Business trip	18.4	n.a.	0.228
			Education during work	1.1	n.a.	0.014
			Education in University	0.9	n.a.	0.012
			Work in free time	0.2	n.a.	0.003
	Neighborhood index	0.04	Go to authority, bank, post office, ATM;	3.3	n.a.	0.011
	Schools	0.06	Education in kindergartens	1.5	Social values and policy preferences Adjustment factor: 2	0.015
			Education in primary schools	2.5	Social values and policy preferences Adjustment factor: 2	0.025
			Education in middle schools	5.8	n.a.	0.029
	Consumer index	0.07	Everyday shopping (e.g., food)	28.1	n.a.	0.163
			Extra shopping (e.g., clothes, furniture)	4.7	n.a.	0.027
			Go for services (e.g., hair dresser)	2.3	n.a.	0.013
	Health	0.15	See doctor in clinics	5.8	n.a.	0.072
			See doctor in hospitals	n.a.	Emergency	0.072
The Supplemental Need	Friendship	0.06	Visit/visited by friends	27.6	n.a.	0.254
			Eating out	n.a.	n.a.	n.a.
	Religious faith	0.03	Go to church and graveyard	5.0	n.a.	0.023
	Organizations	0.04	Youth center	n.a.	n.a.	n.a.
	Recreation index	0.07	Shopping for fun	5.4	n.a.	0.058
			Eating out	7.8	n.a.	0.083
			Visit cultural f acilities	2.4	n.a.	0.025
			Visit event	3.4	n.a.	0.036
			Go to sport	10.7	n.a.	0.115
			Garden house and weekend house	2.2	n.a.	0.023
			Outings (more than 1 day)	1.5	n.a.	0.016

			Holiday	0.5	n.a.	0.006
			Walking	15.8	n.a.	0.169
			Walk the dog	8.6	n.a.	0.092
			Jogging	2.1	n.a.	0.022
			Volunteering, club, political activities	2.1	n.a.	0.023
			Hobby	2.8	n.a.	0.030
			Youth center	0.2	n.a.	0.002
			Playground, play on the streets	1.3	n.a.	0.014
	Natural environment	0.05	Garden house and weekend house	n.a.	n.a.	n.a.
	Getting new knowledge & information	0.07	Training	0.7	n.a.	0.008

[1]"Trip share" is calculated with MiD data (http://www.mobilitaet-in-deutschland.de)
[2]"Relative importance to quality of life" is represented by the regression coefficient (Andrews & Withey, 1974)

Table 2 registers the *standardize weighting factor* for activity types based on the authors' re-interpretation of Maslow pyramid of human needs (**Figure 2**) in a way that maintains to some degree the hierarchy of *deficiency* needs (weighted higher) as compared to *growth* needs with are of less importance. Zheng et al. (2019) two main categories of human needs mimic this structure in classifying 'Fundamental Needs' and 'Supplemental Needs' based on their data and analyses.

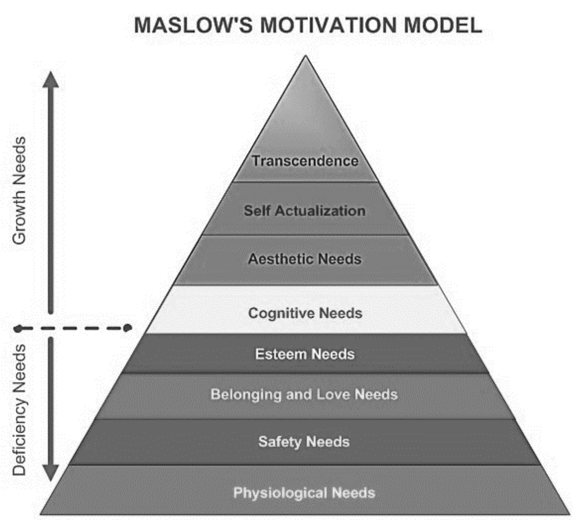

Figure 2: Maslow human need pyramid, Source: https://thepeakperformancecenter.com/educational-learning/learning/principles-of-learning/maslows-hierarchy-

It should also be mentioned that just considering the distance/time between opportunities is not enough. The quality of the path also matters (Southworth, 2005). Some of the factors potentially affecting accessibility by foot are slope; the material of the terrain; presence and quality of sidewalks; safe intersections; among others. However, this paper only focuses on the distance and walking time (5 minute) to opportunities as an influential factor.

Complementing this analysis, I also documented travel behavior (e.g., commute travel mode shares), number of jobs, and number of residents within the pedestrian service areas for each neighborhood using U.S. Census survey data and cross-referenced this travel behavior measure with the accessibility indicator in search of any valuable patterns and insight. This dataset allowed me to compare and find which *New Deal villages* offers more accessibility for pedestrians, and potentially gain insights as to why differences may exist.

4. CHAPTER FOUR: RESULTS

Figures 3,4,5,6 show the four *New Deal villages* within their original boundary and the location of their theoretical village centers. The village centers are identified according to the main commercial and civic areas where most opportunities cluster. The relative size of each village can also be seen as compared to one another and the location of village centers. The area for Greendale village, Wi is 80.43 acres, for Greenbelt village, MD is 73.56 acres, for Greenhills village, OH is 45.13 acres, and for Eleanor Roosevelt village, PR is 87.75 acres.

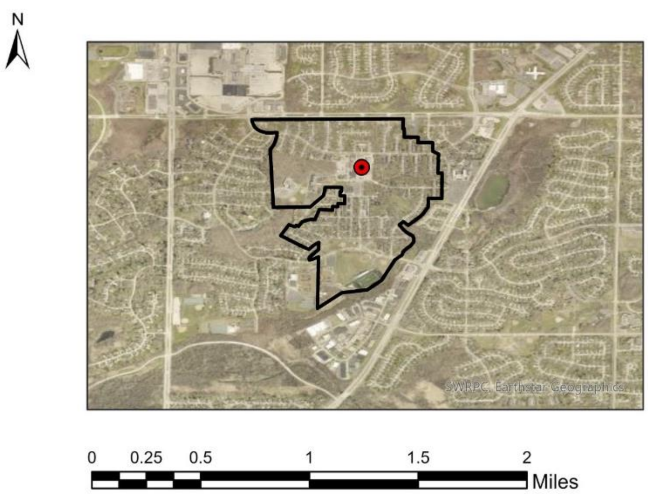

Figure 3: Greendale village, WI boundary and village center, Source: ArcGIS Pro, Areal imagery

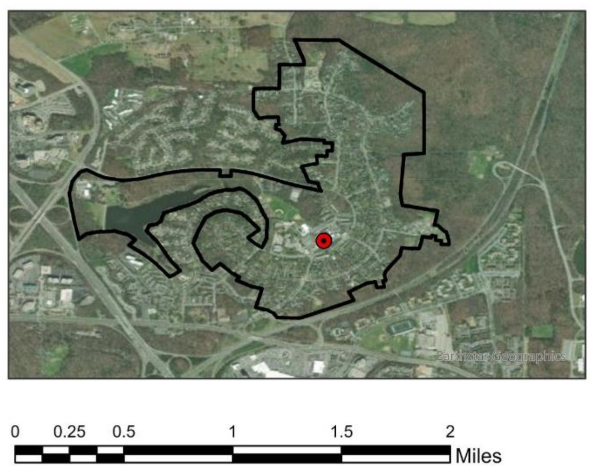

Figure 4: Greenbelt village, MD boundary and village center, Source: ArcGIS Pro, Areal imagery

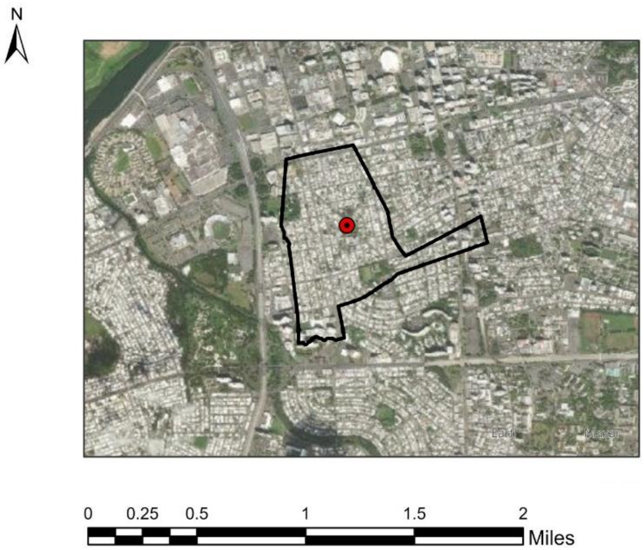

Figure 5: Eleanor Roosevelt village, Puerto Rico boundary and village center, Source: ArcGIS Pro, Areal imagery

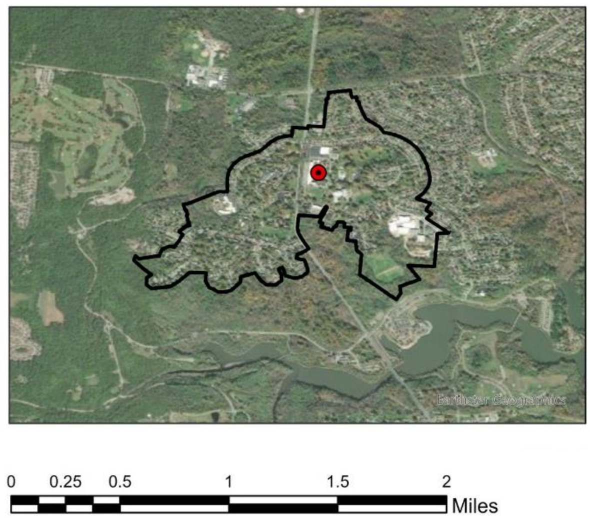

Figure 6: Greenhills village, OH boundary and village center, Source: ArcGIS Pro, Areal imagery

Figures 7-10 reveal that it is only Eleanor Roosevelt village, in Puerto Rico that has a more traditional well-connected grid street network. All other three mainland *New Deal villages* have curvilinear plans that reflect Redburn’s superblock and pedestrian networks influence. This design differences are a key factor affecting accessibility since not only can it make wayfinding much easier, but opportunities can be accessed at a shorter distance by foot in Eleanor Roosevelt. Figures 7-10 below show the street network design for pedestrian and car travel in more detail.

Figure 7: Greenbelt village, MD street network design, Source: UrbanFootprint

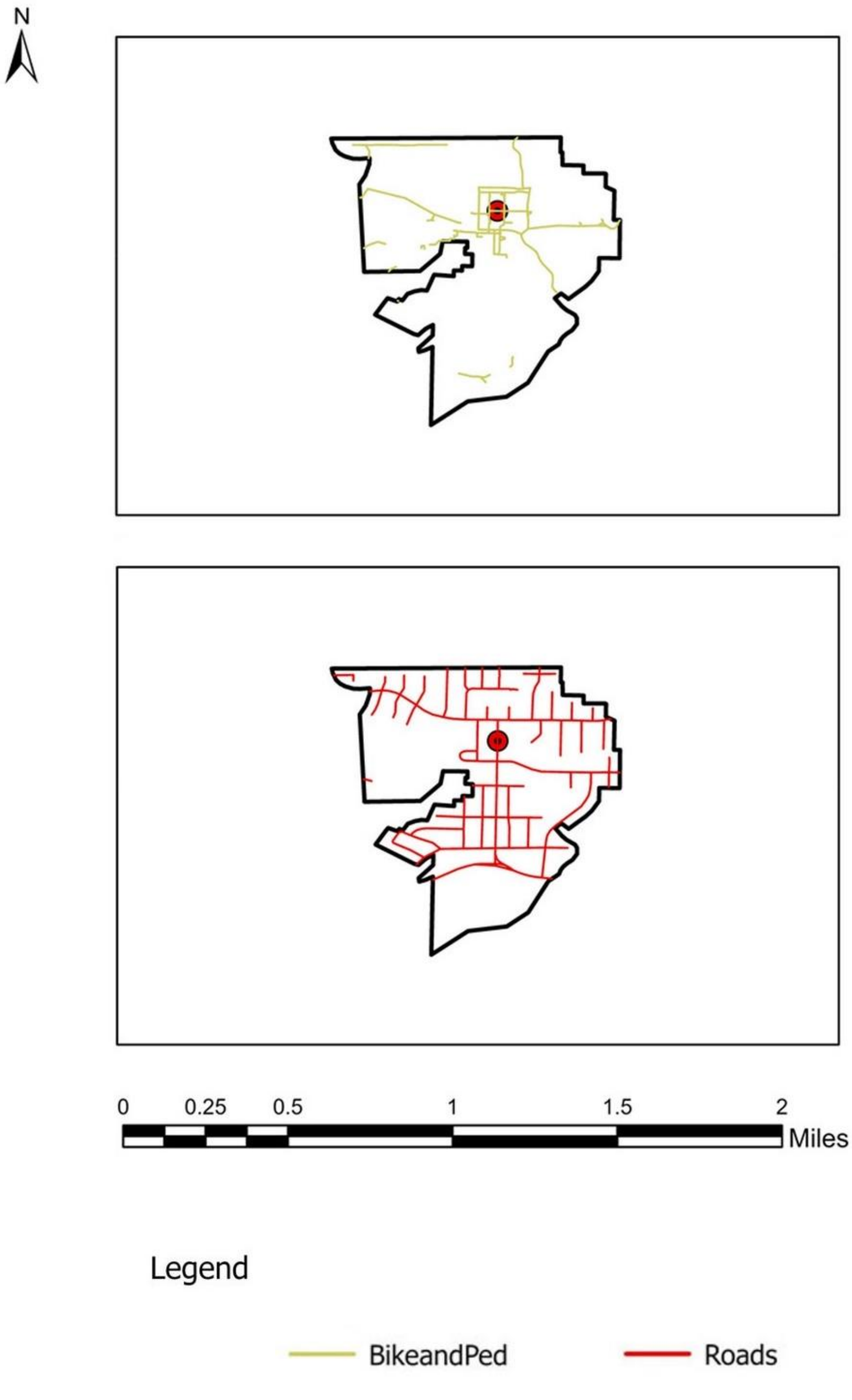

Figure 8: Greendale village, WI street network design, Source: UrbanFootprint

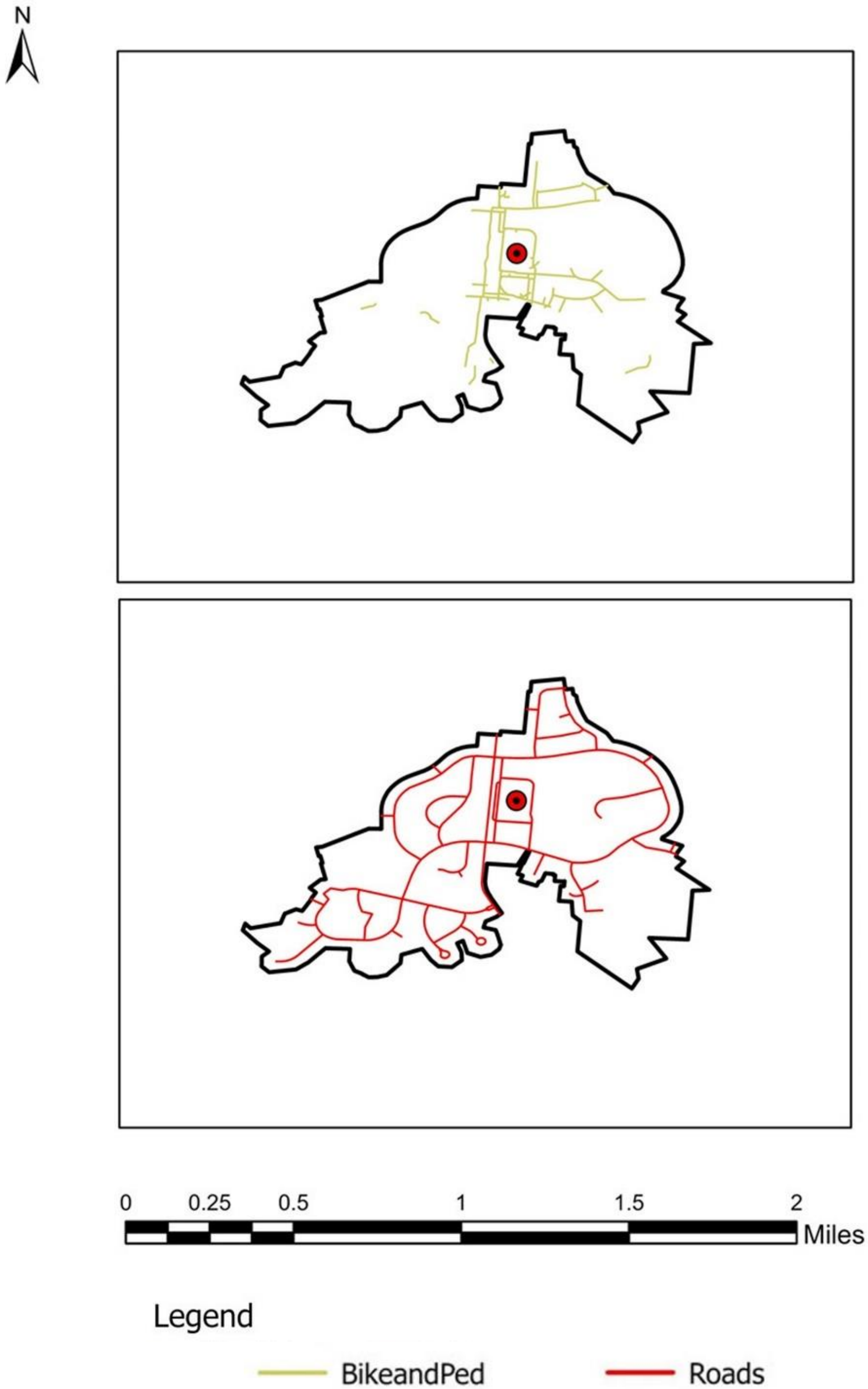

Figure 9: Greenhills village, OH street network design, Source: UrbanFootprint

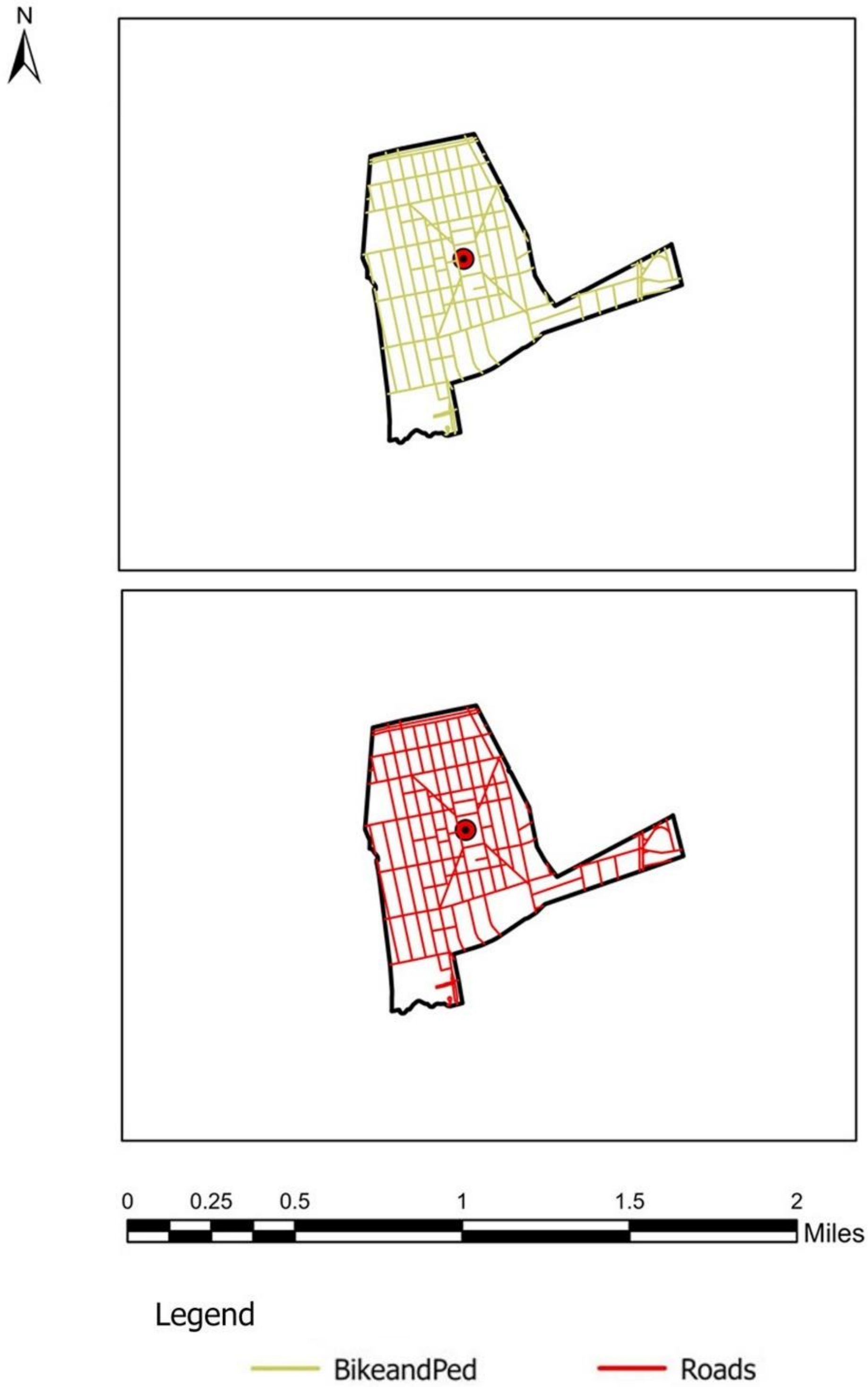

Figure 10: Eleanor Roosevelt village, PR street network design, Source: UrbanFootprint

The figures 11, 12,13,14 show the village boundaries and the POIs captured within the 5minutes pedestrian service areas. These POIs were used to calculate the weighted cumulative opportunities sum.

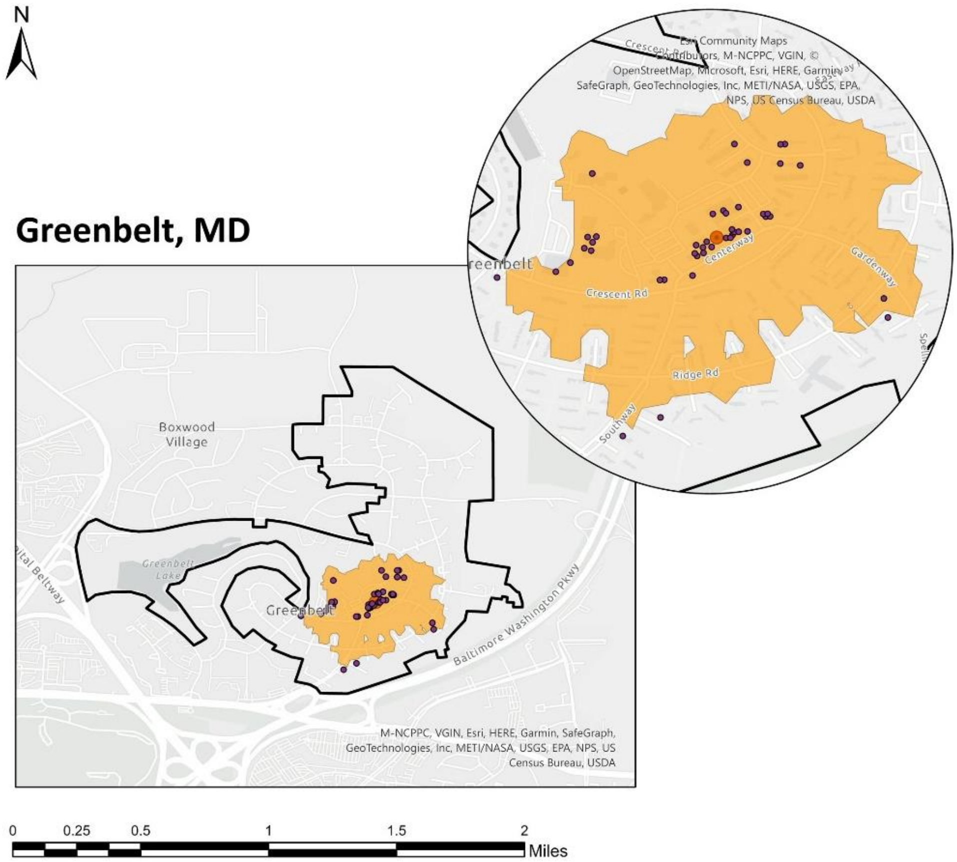

Figure 11, Source: author work in ArcGIS Pro

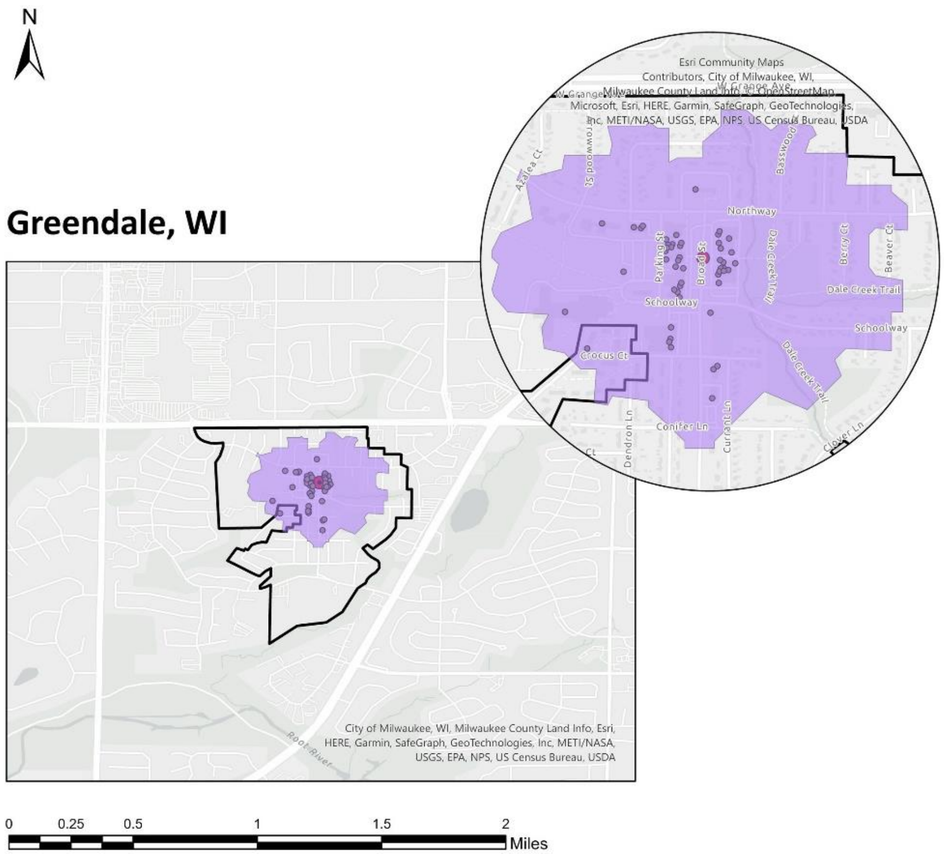

Figure 12, Source: author work in ArcGIS Pro

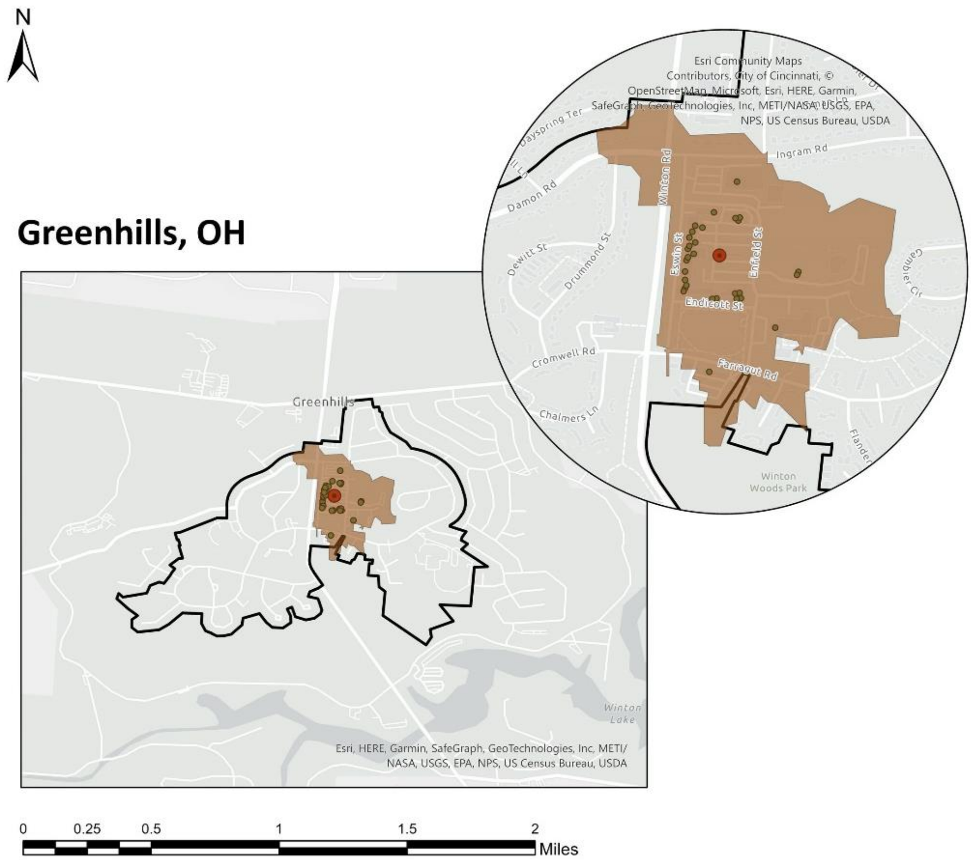

Figure 13, Source: author work in ArcGIS Pro

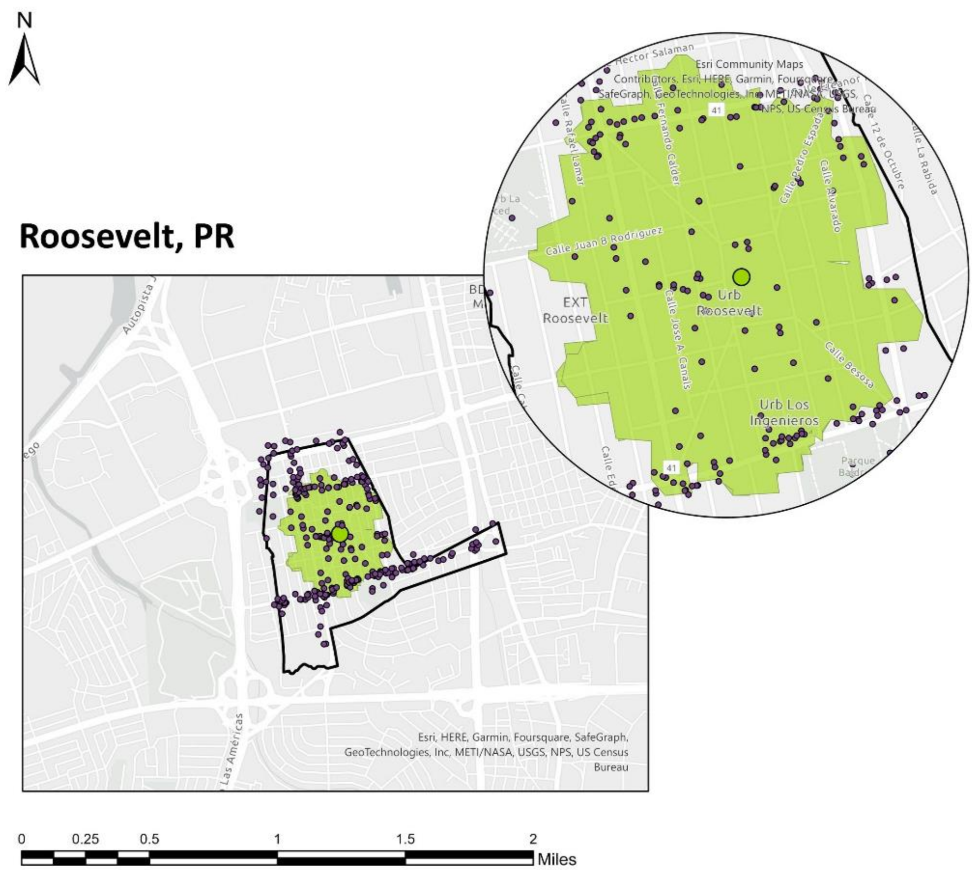

Figure 14, Source: author work in ArcGIS Pro

Accessibility on Foot. The result shows that the pedestrian accessibility index (weighted sum) for Eleanor Roosevelt, PR is the highest, followed by Greenbelt, MD; Greendale, WI; and Greenhills, OH respectively (Table 2). The Walkscore for each village, which is often used as a proxy for walkability in many studies also shows a similar ranking order with Eleanor Roosevelt village having the highest rank. However, the magnitude of differences in Walkscore is less than that registered in the cumulative opportunities' pedestrian accessibility index. This may be due to differences in the way the index is computed.

A comparison of pedestrian service area size among the four villages also indicates a larger figure for Eleanor Roosevelt. This larger size is a direct result of the higher network connectivity associated with more traditional gridded street network coupled with diagonal avenues that lead to/from the village center. This difference in pedestrian service area alone could explain the differences in accessibility and higher level of the Elanor Roosevelt village.

Aggregate Travel Behavior. Sustainable land use and travel behavior theory, and new urbanist literature have advocated for neighborhood designs with smaller block sizes than is typical of contemporary US suburbs; for more connected web-like street networks; and more mix of uses (e.g., number and type of activities) as a way to advance more sustainable development and travel patterns.

Complementary statistics related to population, jobs, and commute mode share was gathered from US Census ACS 2020 block-group level and block-level data (Table 2). The purpose is to assess whether there is any correlation between the design characteristics, pedestrian accessibility levels, and aggregate travel behavior with the expectation to see higher commute walk shares in villages with higher pedestrian accessibility scores and 3Ds (Design, Density, and Diversity) built environment attributes as per new urbanist and land-use/travel-behavior theory.

Results indicate that the share of people walking to their main job is highest in Eleanor Roosevelt village, PR; as compared to Greenbelt, MD; Greendale, WI; and Greenhills, OH that notably register lower share workers walking to their jobs and lower pedestrian accessibility scores.

							% Commute by Mode				
Rank	**Village**	**Pedestrian Service Area (acres)**	**Accessibility index (Weighted Sum)**	**Walk Score**	**Population**	**Employment**	Car	Walk	Transport	Bicycle	Worked from home
1	Roosevelt	87.75	19.50	87	1343	-	69	17	1	0.20	10
2	Greenbelt	73.56	3.24	70	732	465	55	14	23	0.00	6
3	Greendale	80.43	3.06	67	570	364	91	1.6	0	0.16	6
4	Greenhills	45.13	1.77	60	132	63	82	8	0	0.00	8

Table 3: **Quantitative Result and Ranking of Villages Based on 1/4mile Pedshed Area**, Source: Author; US Census ACS 5yr 2020 Block-Group level data; OnTheMap employment population, and block level population from ArcGIS Atlas.
Walk Score source: Walkscore.com.

In terms of demographics, which could be interpreted as a measure of demand and POIs (activities) as supply, Eleanor Roosevelt village also registers a notably higher population as compared to the other three sister *New Deal villages*. Although no data on jobs was available for Eleanor Roosevelt village, it is reasonable to think that it would also register higher a number of jobs given the higher number of activities available within its 1/4mile pedestrian service area. Thus, a higher population and job density is likely to occur at Eleanor Roosevelt village. This attribute is also espoused by contemporary *new urbanist* and *smart growth* models as more encouraging to walking behavior for a variety of trip purposes.

5. CONCLUSIONS

5.1 Discussion

The results from this case study of four *New Deal villages* give credence to the methodology developed to operationalize accessibility on foot, which helps in assessing and comparing different neighborhood planning models and designs. The contour-based cumulative opportunities measure appears to be an effective evaluation tool, and the documented aggregate travel behavior corresponds and correlates with the city planning, neighborhood design, and land-use/travel behavior studies and theories.

The results also appear to support the argument from new urbanist advocates that a highly interconnected web-like approach to street network design, and a more mixed land-use plexus that accommodates more and a more diverse set of activities would yield more sustainable travel behavior, in this case, walking to work. However, it must be noted that the cultural and governance contexts in which these villages were created and in which they have evolved during the past 86 years are quite distinct; and this could have had an effect on the resulting pedestrian accessibility indicators and ensuing travel behavior.

It has been noted elsewhere (Ramos-Santiago et al., 2014) that lower-income suburbs in the city of San Juan (PR) experience a relatively weak governance of the build-environment. This manifest as non-compliance with zoning and/or building regulations, parking requirements, sidewalk provision, among other codes and legal violations. A similar transfiguration of Eleanor Roosevelt village has been taking place since early in its development, as noted in archival records and recent field observations. Change in land-use and building footprints, increase in number of stories, and conversion from residential to commercial uses are some of the events that have transpired in contradistinction to the more stable (or restricted) trajectories of Greenbelt, Greendale, and Greenhills that for the most part retain their original suburban character, green spaces, and building typologies and architecture.

Distinct cultural, legal, and institutional regimes and their degree of effectiveness in enforcing policy are often found when comparing developed and developing countries, such as mainland United States and Puerto Rico. The point here made is that the higher number and variety of activities present at Eleanor Roosevelt, which isno longer a suburban *New Deal villages* but a still evolving urban village, as compared to the other three sister *New Deal villages*, is likely result of a weaker governance in the management of suburban land uses that has existed since early in the development of the community.

All four villages shared a common land use program in the number and type of activities to be located at or near each village center (e.g., community center, park, school, churches, retail, cinema, etc.). Yet, Eleanor Roosevelt village accommodates a large number of POIs along arterials.

An unplanned consequence of such organic evolution in Eleanor Roosevelt village is higher pedestrian accessibility, due to a higher number of activities (POIs) beyond the original and more centered functions. This higher accessibility by sustainable travel modes (e.g., walking) is highly valued and advocated in new urbanist and sustainable development discourses.

On the other hand, the informality displayed at Eleanor Roosevelt's has erased the original scale and suburban architectural character and cohesiveness. And some would argue degraded the aesthetic quality of the neighborhood. Likewise, weak governance of the built environment manifests in substantial loss of green areas in Roosevelt village, often caused by conversion and paving of front lawns or sidewalks to accommodate motor vehicle parking spaces for new commercial activities (Ramos et al. 2014)

Weak governance can allow an increase of activities, but it can also decrease the quality of the pedestrian infrastructure and thus of accessibility as well. Governance of on-going transformations that would allow for more destinations to appear within the neighborhood and that maintain pedestrian infrastructure is needed.

Following are some streetscape pictures of the four villages taken from Google Map Street View. It can be seen how more opportunities (POIs) are provided in Roosevelt within walking distance, yet there is a higher density and a more disorderly arrangement of vehicles; and sidewalk blockage is evident in some areas. Greenhills and the other two mainland greenbelt towns display a more curvilinear street design and cul-de-sacs with some lacking sidewalks; and less density of people and destinations that make it harder for pedestrians to directly reach their destination.

Although it was not addressed nor measured in this project due to resource limitations, it is also important to evaluate the quality of the pedestrian infrastructure. This likely influences levels of accessibility by foot and rates of walking for a variety of purposes. Street and intersection audit instruments such as PEDS and Ped-Bike ISI Intersection Safety protocol would add an important qualitative dimension in future studies.

Figure 15, Street views in Eleanor Roosevelt village, Puerto Rico, Source: Google map street view

Figure 16, Street views in Eleanor Roosevelt village, Puerto Rico, Source: Google map street view

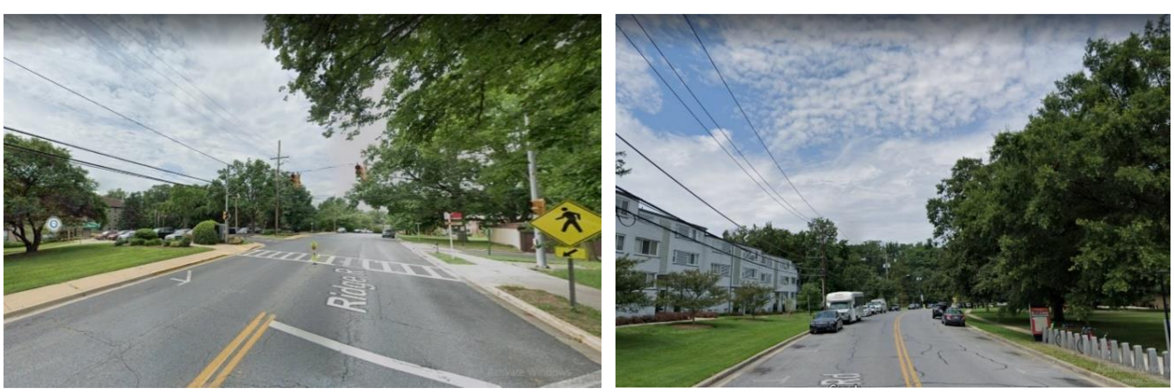

Figure 17, Street views in Greenbelt village, MD, Source: Google map street view

Figure 18, Street views in Greenbelt village, MD, Source: Google map street view

Figure 19, Street views in Greendale village, WI, Source: Google map street view

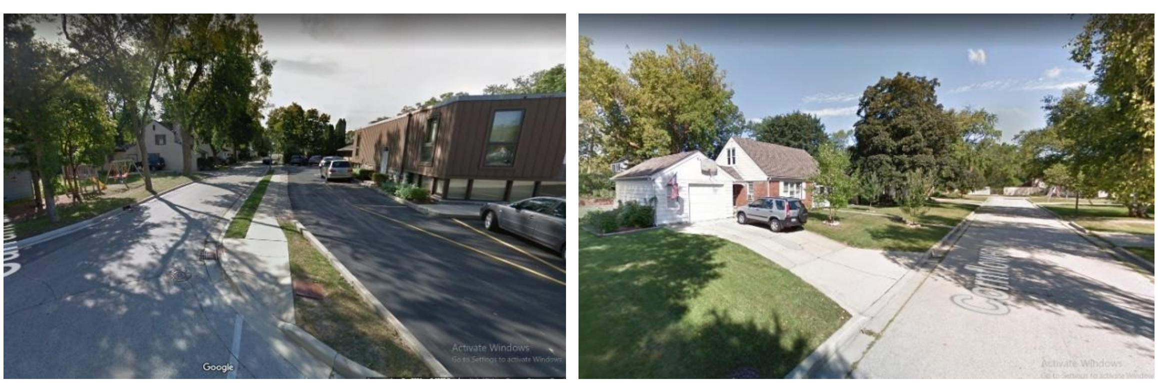

Figure 20, Street views in Greendale village, WI, Source: Google map street view

Figure 21, Street views in Greenhills village, OH, Source: Google map street view

Figure 22, Street views in Greenhills village, OH, Source: Google map street view

5.2 Recommendations

Given the results and insights from this multiple-case study, I present the following recommendations for improving accessibility levels in lower-ranking villages and offer guidance to future new developments:

1. A contour-based cumulative opportunities model can be effective and feasibly estimated for pedestrian accessibility evaluations of both existing and proposed neighborhoods using readily available data and relatively affordable software; and by applying intermediate level GIS tools and protocols. Designers in private and public sectors and planners in public positions could incorporate this type of accessibility indicator as part of their daily practice and in development evaluation protocols. Communities could define desirable or minimum pedestrian accessibility thresholds that new developments would need to adhere to, and existing communities could aspire to.
2. Designing well connected web-like street networks rather than superblocks and Cul-de-sacs. Design a highly connected web-like street network for multiple users and modes (pedestrian, bicyclist, motorist), which yields smaller blocks, will also yield larger pedestrian service areas, and likely result in higher pedestrian accessibility levels when combined with a higher number of destinations (activities) in the community.
3. Allowing more activities to be located within the 5 minutes walking distance to encourage people to walk to their destination rather thar taking their car. This might

entail a relaxation of current development codes that may be,or not, politically acceptable in some communities.

4. Protecting existing and providing appropriate and safe sidewalks with a sense of enclosure for pedestrians, which implies a different set of building typologies than the typical single-family home, or smaller plat footprints and front yard setbacks. This entails improving the monitoring and management of the build-environment, especially in the Elanor Roosevelt village.

5.3 Study Limitations

Case studies tend to be limited in term of the generalization of the insights and results, as compared to larger empirical quantitative studies; also, the contour-based cumulative opportunities measure developed by myself and my advisor could be improved by integrating a distance-decay friction factor in the equation, as done by WalkScore. Indeed, accessibility decreases as distance increases, due to factors such as travel time, transportation costs, and physical barriers. By integrating this factor into the equation, the contour-based cumulative opportunities measure could more accurately reflect the true accessibility of different areas in larger pedestrian sheds.

There are also other factors that can affect accessibility, including the population levels, the layout of the area, and the availability of transportation options such as transit. Areas with higher populations may require more amenities and services, such as schools, hospitals, and shopping centers. So, equal number of opportunities/amenities may not be adequate for areas with different n population levels and/or a bigger area. Higher populations also tend to require better transportation infrastructure, such as public transit systems and highways. This can make it easier for people to get around and access different parts of the neighborhood and/or city by combining walking with other modes, which again can increase their overall accessibility.

As noted earlier in this document, incorporating the quality of the pedestrian infrastructure is another improvement to accessibility evaluations as differences in quality likely impact rates of walking, all else equal. Apart from that, not everyone in an area has equal access to all amenities and services. In many cases, certain groups may face barriers to accessing these resources due to factors like income, disability, or discrimination.

Overall, contour-based cumulative opportunities measure can be improved by considering infrastructure quality, population, size of area, different types of transportation, level of income, disability, among other factors in determining accessibility in an area.

REFERENCES

- Congress for the New Urbanism, Sustainable Street Network Principles, 2012. [accessible at www.CNU.org]
- El-Geneidy, A. M. and Levinson, D. M., Access to destinations: Development of accessibility measures, 2006.
- Forsyth A. and Southworth M., Cities Afoot—Pedestrians, Walkability and Urban Design, 2008.
- Funihashi K., A study of pedestrian path choice. Working Paper, Center for Architecture and Urban Planning Research, The School of Architecture and Urban Planning, Univ. of Wisconsin, Milwaukee, Wis, 1985.
- Handy S., Urban form and pedestrian choices: Study of Austin neighborhoods. Transportation Research Record, 1552, Transportation Research Board, Washington, D.C., 135–144, 1996.
- Jaskiewicz F., Pedestrian level of service based on trip quality. Transportation Research Board Circular E-C019: Urban Street Symp., Transportation Research Board, Washington, D.C., 2001.
- Koenig J.G., Indicators of urban accessibility: theory and applications. Transportation 9, 145–172. 1980.
- Komanoff C., Roelofs C., The environmental benefits of bicycling and walking. National Bicycling and Walking Study, Case Study No. 15, Federal Highway Administration, Washington, D.C., 1993.

- Karst T, Geurs K.T., Van Wee B. Accessibility evaluation of land-use and transport strategies: review and research directions. Journal of Transportation Geography. 2004.
- Levinson D. Wu H. “Towards a General theory of Access”, Journal of Transportation Land Use, 2020.
- Philippe Apparicio, Jérémy Gelb, Anne-Sophie Dubé, Simon Kingham, Lise Gauvin, Éric Robitaille, The approaches to measuring the potential spatial access to urban health services revisited: distance types and aggregation-error issues, Journal of Health Geographic, 2017.
- Ramos-Santiago L. E., Villanueva-Cubero L., Santiago-Acevedo L.E., and Rodríguez-Meléndez Y.N., “Green Area Loss in San Juan’s Inner-ring Suburban Neighborhoods: A Multidisciplinary Approach to Analyzing Green/Gray Area Dynamics.” Ecology and Society 19(2): 4. 2014. [accessible at http://dx.doi.org/10.5751/ES-06219-190204]
- Siddiq F. and Taylor B., “Tools of the Trade? Assessing the Progress of Accessibility Measures for Planning Practice”, Journal of the American Planning Association, 2021.
- Southworth M., “Designing the Walkable City”, Journal of Urban Planning and Development, 2005.
- Southworth M., and Ben-Joseph E. Streets and the Shaping of Towns and Cities, Island Press, Washington, D.C., 2003.

- Southworth M. and Ben-Joseph E. "Reconsidering the cul-de-sac." Access, 24, Spring, 2004.
- Smith M., and Butcher, T., Parkers as pedestrians. Urban Land, 536, 9–10, 1994.
- Weinstein A. “Pedestrian Walking Behavior: A Review of the Literature.” Working Paper, University of California at Berkeley, Berkeley, California, 1996.
- Zheng L., Oeser M., Van Wee B., Combining Accessibilities for Different Activity Types: “Methodology and Case Study, 2019”.