Transit, walking and cycling infrastructure and sustainable development in Enugu city, Nigeria

Transit, walking and cycling infrastructure and sustainable development in Enugu city, Nigeria

Andrew E. Okosun[1], **Francis O. Okeke**[2,3], **Ajuluchukwu E. Igwe**[2], **Emmanuel C. Ezema**[2*]

[1] Department of Urban and Regional Planning, University of Nigeria, Nsukka
[2] Department of Architecture, University of Nigeria, Enugu Campus
[3] School of Engineering, Technology and Design, Canterbury Christ Church University, UK

* Corresponding author: emmachigozie.ezema@unn.edu.ng

Abstract. In a predominantly urban world, people's ability to move within cities is a critical driver of sustainability. The transportation system which constitutes a large percentage of the physical urban environment provides mobility and aid economic sector. However, it contributes to several major environmental pressures including pollution, congestion, accidents, waste accumulation, resources depletion and disruption of nature. While urban population growth and increase in economic activities combine to generate higher demand for transportation services and heighten the problem. How to effectively deal with these imposing threats and simultaneously provide optimal mobility for city dwellers is the backbone of this research. Drawing experiences from developed cities, the study used Achara layout in Enugu as a case study. From observation, surveys and published literature data were collected and analysed qualitatively. The primary data include, physical traffic count, existing road character, traffic infrastructure and demographic statistics. Findings show the extensive sterility of Enugu's urban infrastructure to motorized traffic and lack of provision for walking and cycling. It recommends strategies for planning and managing the urban environment which recognizes and acknowledged the social, environmental and economic realities. The conclusion demonstrates that cities designed for pedestrians and cyclist are cities designed for people and sustainable development.

Keywords: Urban environment, Transportation, Infrastructure, Cities, Sustainability, Enugu

1. Introduction

The urban population in third world countries is anticipated to continually multiply and by 2050, the world's cities will house an additional 2.5 billion people, with Asia and Africa (particularly Nigeria) contributing nearly 90 percent of the rise [1]. By then, three-quarters of global populace would be concentrated in cities. This population growth has a direct effect on the urban transportation system with colossal and escalating imprints on environmental, social and economic spheres. However, transportation propels development by building connections, integrating local communities and people to the rest of the world, creating markets, and facilitating trade. According to Lagan and McKenzie [2], transportation links people, goods, and services; as a result, motorized transportation is perhaps the most widely used mode of urban transportation in many developing countries. Also, because of technological advancements and general improvements in living standards, automobile dependence has skyrocketed [3,4]. Rapid motorization has inevitably shifted future mobility demands away from the more

environmentally friendly travel modes such as public mass transit and non-motorized modes like cycling and walking towards the use of private cars [5]. In third world countries like Nigeria, having inefficient public transportation system accompanies a more severe consequence. In such nations, problems like road congestion, pollutions related to transportation, and auto-crashes are usually prevalent [6]. These challenges contribute to making the transport system unsustainable. Sustainable transport system stimulates sustainable development, which is essential in attaining the needs of people in their personal and economic lives, while respecting future generation's ability to meet their needs. According to United Nations [7], the huge social, environmental, and financial implications of continuing with "business as usual require immediate attention. Furthermore, the United Nations statistics reveals that 1.24 million people die in auto crash each year, with another 3.5 million premature deaths as a result of outdoor pollution from transportation sources. Also, transportation and traffic congestion are responsible for a substantial share of energy-related greenhouse gas (GHG) emissions, accounting for approximately 23 percent of the total [8]. This considerable contribution has significant implications for regional and global economy, as it leads to a substantial drain on resources. Therefore, addressing the challenges associated with transportation and traffic congestion is crucial for mitigating GHG emissions and promoting sustainable economic development.

At the dawn of the 21st century, it is evident that Nigerian urban areas are grappling with a persistent and immensely challenging problem: the inadequacy of city infrastructure and the subsequent degradation of the urban environment [9]. This issue poses significant obstacles to the sustainable development and well-being of urban communities in Nigeria. The transportation system which constitutes a large percentage of the physical urban environment provides mobility. However, it is important to recognize that transportation is not an isolated objective but rather a means through which individuals gain access to essential goods, services, and experiences that contribute to their overall well-being and fulfilment. It is therefore the duty of the government and city planner to ensure this purpose is not jeopardized, unfortunately this is not the case in Nigeria. This current study aimed at identifying avenues for transitioning traffic and transportation within urban centers towards transit, cycling, and walking infrastructure, with the aim of fostering sustainable development in Nigeria. Specifically, the study focused on the Achara layout in Enugu, with the purpose of addressing the prevalent transportation bottlenecks in this urban area and proposing viable solutions. Through a rigorous examination of the existing transportation landscape, an innovative proposal was formulated, intended to be embraced by the government as a means to attain a sustainable built environment. The findings of this study contribute to the ongoing discourse on urban transportation planning and offer valuable insights for policymakers and urban development practitioners in Nigeria and beyond. This research becomes significant in the current search for sustainable solution on how to accommodate the growing urban population in developing cities and ameliorate challenges of mobility condition for the urban poor.

2. Literature review

Throughout history, urban planning and architecture have morphed strategies to address the prevailing conditions associated with time and changes in its environment [10]. Sustainable transport according to The United Nations [7], is the establishment of services and infrastructure that facilitate the movement of individuals and goods in a manner that ensures safety, affordability, accessibility, efficiency, and resilience. This approach aims to curtail carbon emissions, as well as other detrimental environmental impacts, with the objective of benefiting both present and future generations in social and economic spheres. By prioritizing sustainable transportation practices, societies can engender a harmonious coexistence between human mobility and environmental preservation, thereby fostering a more sustainable and inclusive future. A substantial portion of the pressing and worrisome issues, such as reliance on fossil fuel, social isolation, impoverished circumstances, and rising temperatures can be traced back to unsustainable human activities. Remarkably, a significant nexus exists between these challenges and the transportation sub-sector. Transportation plays a pivotal role in exacerbating these issues due to its substantial reliance on fossil fuels and associated greenhouse gas emissions, its impact on climate change, and its contribution to socio-economic disparities. Recognizing the intertwined nature of these challenges, it becomes increasingly imperative to address and transform the transportation sector towards sustainable practices. Many of the sector's bloated environmental footprint

blames, can be found in the continuous overdependence on automobiles observable in many urbanized cities of the world. Increased automobile usage also resulted from the physical expansion of cities caused by the cluster of people in multifunctional city centers, which was facilitated by improved transportation infrastructure. On a daily basis, cities across the globe witness an astonishing number of approximately 8 billion trips, with nearly half of them (47%) being undertaken using private automobile, predominantly powered by fossil fuels [11]. This extensive reliance on conventional means of transportation underscores the magnitude of the challenge at hand in terms of mitigating the associated environmental and sustainability impacts. In view of this, efforts have been made to introduce electric cars in some developed countries.

2.1. Non-motorized transport and public transit

According to OCASI [12], the least intrusive travel form that is safest and healthiest is cycling and walking; perhaps they are the most affordable two predominant forms of non-motorized transport. Walking has been considered as the only form of transportation for the very poor. In developing centres majority of the urban poor are seen as “captive walkers”, meaning that it is very difficult for them to fund any alternative means of travelling.

An adequately connected and secure pedestrian environment holds paramount importance in enabling individuals to fulfil their daily requirements. Walking, being the most cost-effective mode of transportation, offers urban populations with limited resources the ability to allocate their income to other essential needs, thereby making a significant contribution to poverty reduction [5]. Recognizing the significance of promoting walkability within urban areas is crucial for ensuring equitable access to basic amenities and fostering socio-economic well-being among vulnerable communities. Consequently, in recent times, bicycles are used for more trips in some developed cities because they are considered environmentally friendly. Although Jain [13] research shows that bicycles function as a form of mass transit in the world's most impoverished cities, particularly through the utilization of cycle rickshaws. These cycle rickshaws have become a prevalent mode of transportation in countries such as Sri Lanka, India, Pakistan, and Bangladesh. By embracing this affordable and environmentally friendly means of travel, these nations are addressing the mobility needs of their populations while also fostering sustainable transportation options. Despite being the primary mode of transportation for the urban poor, public transit and non-motorized modes are rapidly losing patrons to personal automobiles in many cities [14]. As remarked by Pourbaix [11] walking and cycling recorded just 37% of global travel in 2005, while public transit accounted for 16%. Simultaneously, informal transport modes are metastasizing to fill the yawning gap of inadequate public transport services. If these trends continue unabated, the International Energy Agency [15], projects that by 2050, the share of global GHG emissions for transportation may reach 40%. Cities are caught in a detrimental cycle as motorization rates rise and substantial investments are made in the expansion of roads and highways. This cycle perpetuates a reliance on private car usage, leading to the proliferation of urban sprawl and necessitating further construction of roads, thereby exacerbating the dependence on private vehicles. The consequences of this vicious cycle are manifold, and it is imperative for city planners and policymakers to break free from this cycle.

2.2. Urbanization and Motorization

The process of rapid urbanization witnessed since the mid-20th century has been closely intertwined with the phenomenon of urban sprawl. This form of expansive urban growth, characterized by the outward spread of development, has emerged as a prominent spatial pattern in many regions. However, the implications of this sprawling growth extend beyond spatial considerations and have significant financial ramifications for cities and societies. It not only increases reliance on automobiles, but it also consumes arable land and green open spaces, endangers waterbodies and natural habitats, and burdens urban reserves with both the huge costs of broadening and maintaining urban services and infrastructure [16]. The evolution of motorized movements in cities has both fuelled and shaped urbanization epidemic. The global number of motorized cars is rising at an extraordinary rate. In 2010, nearly 1.2 billion passenger vehicles were registered worldwide [17,18]. Based on data from half a decade ago, it

was observed that private motorized means accounted for approximately half of all municipal trips, and this proportion has been steadily increasing [11].

3. Study area

Enugu is a moderately sized city in Nigeria's south-eastern region, with the coordinates 6°30′N 7°30′E. According to the 2006 Nigerian census report it is 9th most populated city that boasts of over 722,664 inhabitants and a population density of 3,400 people per square mile equivalent to 1,300 people per square kilometer [19]. It is a place of residences to most Igbo indigene of southern Nigeria and the capital metropolis of Enugu State. The city is regarded as the earliest urban residence of Nigeria's South-eastern Igbo-speaking region, and its historical significance stems from the discovery of coal by British geologists in 1909 [20]. It has an area of 215 square miles (556 square kilometers) and is subjected to the Tropical Savanna weather. The metropolis comprises of three local government areas namely: South, North and East [21].

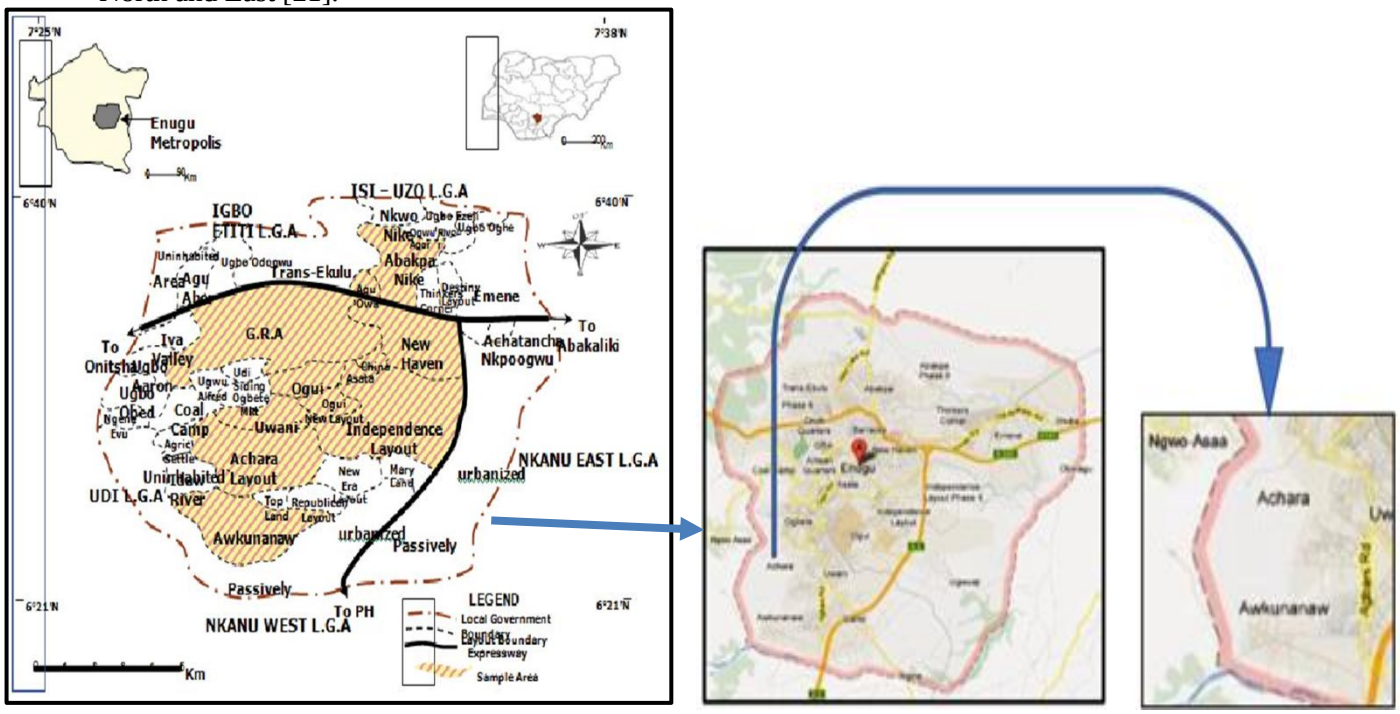

Figure 1. Map of Enugu urban showing Achara Layout

Enugu South Local Government Area in Enugu State houses Achara Layout. The Local government area has an area of approximately 106 km^2 and an estimated population of 244,852 [22]. Achara Layout, initially designated for residential development in the early 1960s, has undergone a notable transformation from a residential neighbourhood to a thriving commercial district, particularly along Agbani Road, the principal thoroughfare (refer to Figure 2). The streets within this area are characterized by densely packed low-rise apartment buildings, contributing to a vibrant urban fabric. Presently, the population of Achara Layout stands at 72,894 individuals [22], with projections estimating a future population of over 112,321 residents. Figure 3 depicts the layout, which has a grid-patterned transportation road network with an average street width of 7.6m and thus is accessible from various parts of the city. The streets have no defined provision of walkways for pedestrians nor cyclist. The neighbourhood is densely populated given that it is residence to many Enugu's working-class people.

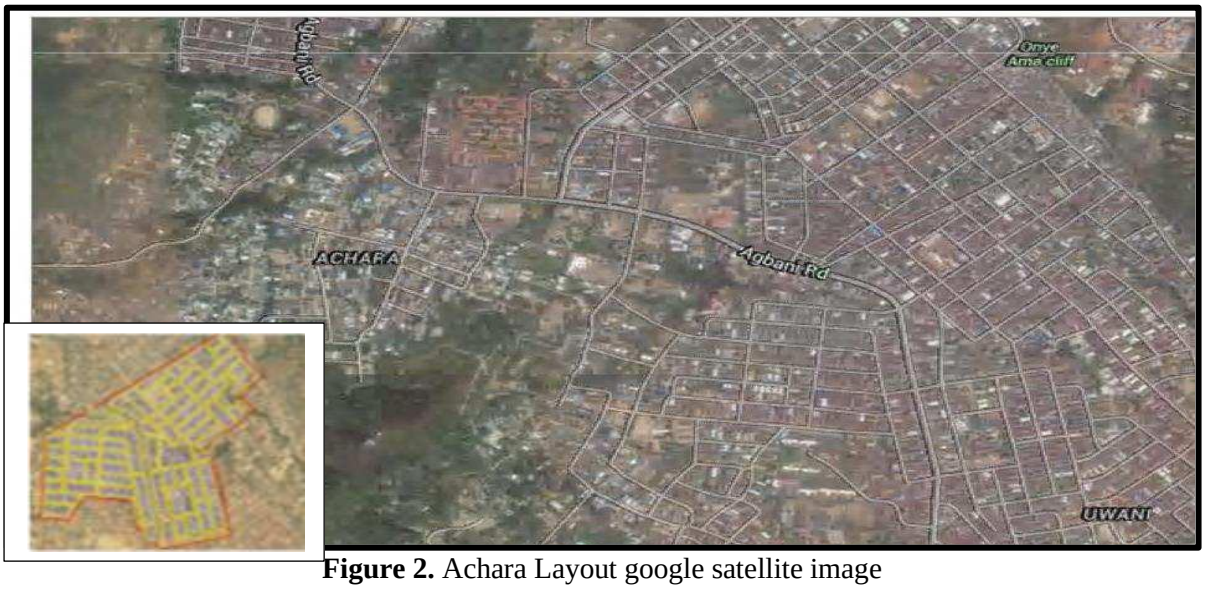

Figure 2. Achara Layout google satellite image

Figure 3. Drafted map of study area

4. Research methods

This report is a component of an extensive investigation on the urban transport and traffic issues in the Nigerian city of Enugu. The study makes use of a qualitative approach using a descriptive survey research design that employs both secondary and primary methods for data collection. Purposively, Achara Layout in Enugu South was the selected study area based on a simple random sampling technique. It was considered for the study because it is a residential zone with road network linking from several neighbourhoods in the metropolis and the district did subsist successive government regimes to the present era; accommodating a sizable proportion of Enugu's population being that it is heavily built-up with block of flat apartment. The data collection instrument was an observation schedule with a reconnaissance field survey in which the authors took physical street size measurement of local roads

with a 30m glass fibre tape and photographic images to substantiate the study's findings. Also, a half day physical traffic count was done from 7am-7pm by four research assistants at the major bus stop of the layout to calculate the volume and flow of automobile traffic for the layout. Various type of automobile plying the roads were censused and recorded. The literature review in this study drew upon a range of secondary sources to gather relevant data, including the internet, conference and journals articles with demographic figures extracted from the 2006 Nigeria national population Census results for the city of Enugu. The population result was projected to 2020 by the researcher applying Exponential Model of [23]. Data of the neighbourhood land use plan contained in published literature of [24,25] were sieved and used as basis for thematic analysis. Through deductive analysis and the researchers' expertise, these sources were utilized to gain insights and form opinions on the subject matter. The findings of the study were then presented through a combination of tables, maps, and explanatory text, facilitating a clear and accessible interpretation of the results.

5. Results

The land use map analysis of achara layout as seen in Figure 4 shows that it is a grid patterned residential district and has a total floor area of 1,081,460m^2 [24]. The geospatial studies of [25] validated by the reconnaissance survey of the authors, indicated that the Landuse analysis of the area include transportation and built-up residential zone with supporting neighbourhood amenities like school, worship centre and green fields. These identified land uses occupy 365,720m^2 and 715,740m^2 respectively. Also, as observed during the survey, the land areas initial mapped out for green/open spaces have been built-up due to rising population, commercial space, and housing demand.

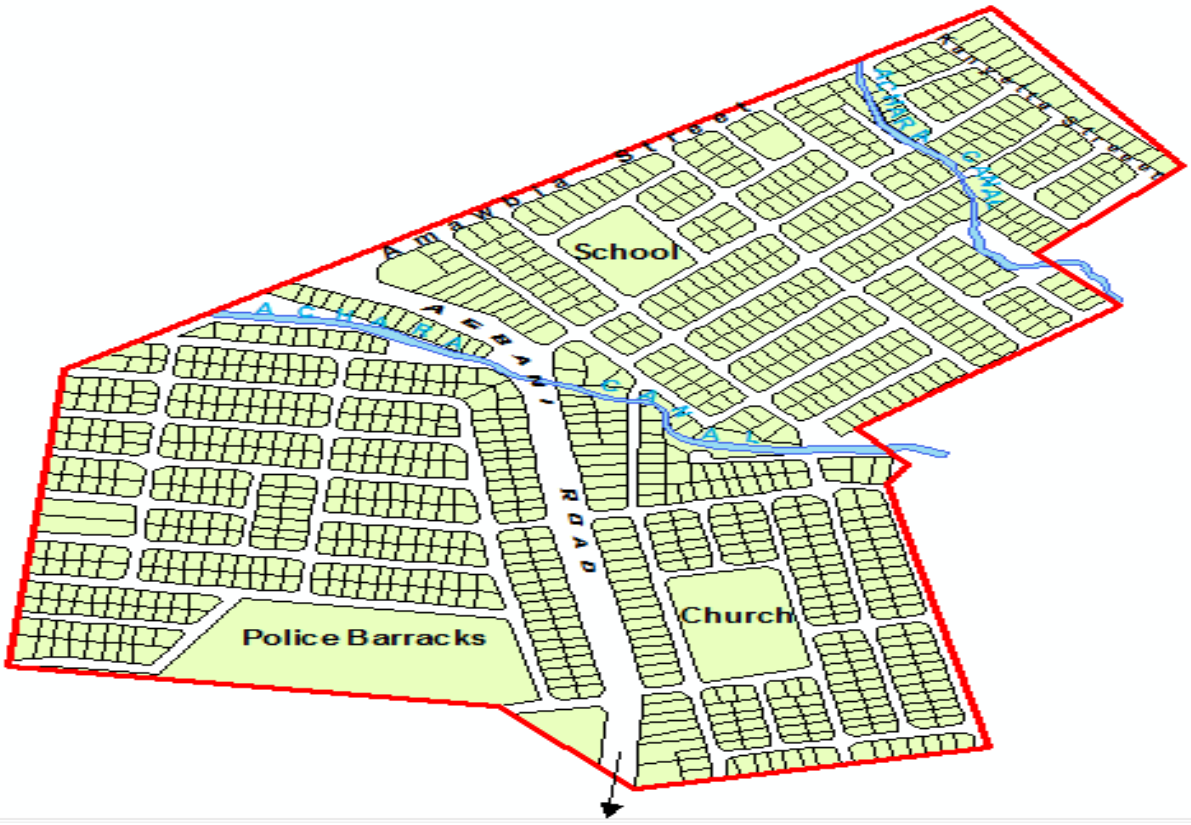

Figure 4. Achara Layout land use map

The real-time traffic census findings are reported in table 1, with the various automobile types that ply the Layout roads. Peak hour traffic and volume were also observed and shown.

Table 1. Half day traffic census of Achara Layout

AGBANI ROAD (MAYOR)									
PERIOD OF TRAFFIC CENSUS FROM 7:00am-7:00pm									
Period	**Private Cars**	**Public Cars**	**Comm. Public Bus**	**Private Bus**	**Tipper /Lorries**	**Trailer Vehicle**	**Tricycles**	**Motorcycles**	**Total**
7:00-8:00am	252	68	592	23	15	3	480	2	1445
8:00-9:00am	468	127	766	30	25	4	960	1	2371
9:00-10:00am	462	134	617	27	31	4	1085	-	2360
10:00-11:00am	565	74	544	31	27	1	825	-	2067
11:00-12:00pm	630	78	554	43	36	3	899	-	2241
12:00-1:00pm	406	70	493	26	33	4	654	-	1686
1:00-2:00pm	385	48	498	21	14	2	618	-	1586
2:00-3:00pm	391	103	564	37	27	4	665	1	1792
3:00-4:00pm	477	171	673	15	16	2	637	1	1892
4:00-5:00pm	340	77	632	33	17	6	527	4	1636
5:00-6:00pm	292	69	559	25	16	2	662	1	1666
6:00-7:00pm	249	70	530	18	10	2	557	-	1436
TOTAL VOLUME	**4927**	**969**	**7050**	**329**	**267**	**37**	**8569**	**10**	**22178**

According to the Table 1, the total number of vehicles is 22178, with tricycles having the largest travel count of 8569 as at the time of study, while motorcycles have the least travel count. The obvious reason was the government restriction on its use within the city in 2012 due to its perceived related crime activities [26]. Morning periods 8am and 9am were the recorded peak hour traffic attributed to movement to work and schools. However, during peak hours the usage patterns of different automobile types vary significantly. It remains evident that commercial vehicles consistently experience peak traffic during the morning hours, specifically between 8am to 10am. This observation underscores the fact that a substantial volume of commuting activity, primarily associated with school and work travel, transpires during this period.

Subsequently, Table 2 reveals 1991 Population Census community results and the 2006 Local Government Area census results for Enugu state and future projections.

Table 2: Results of the Enugu South LGA population census projected to 2020.

Locality	**Males**	**Females**	**1991 Both Sexes**	**2006 Both Sexes**	**2015 Both Sexes**	**2020 Both Sexes**
Amaechi Awk	6,105	7,336	13,441	19,422	25,788	29,939
Obeagu	2,453	3,034	5,487	7,928	10,526	12,222
Akwuke	1,625	1,701	3,326	4,806	6,381	7,408
Uwani	15,698	16,177	31,875	46,058	61,155	70,999
Ugwuaji	3,879	4,267	8,146	11,771	15,629	18,145
Maryland	2,491	2,175	4,666	6,742	8,952	10,393
Achara Layout	24,643	25,804	56,447	72,894	96,788	112,321
Gariki	10,013	9,649	19,662	28,411	37,724	43,795
L.G.A TOTAL	**66,907**	**70,143**	**137,050**	**198,032**	**262,943**	**305,222**

Statistical data from Nigeria head count clearly demonstrates there is a progressive rise of Achara layout demography from 50,447 in 1991 to 72,894 in 2006 to 96,788 in 2015 and extrapolated 112,321 in 2020. From the trajectory, the numbers are going to keep increasing.

Figure 5 demonstrates the spatial distribution of population concentration within parcelled blocks in Achara Layout, allowing for an examination of its impact on transportation dynamics, as highlighted in the study referenced as [25]. It utilized a 5-point scale, ranging from regions with minimal population density to those characterized by significantly higher population concentrations.

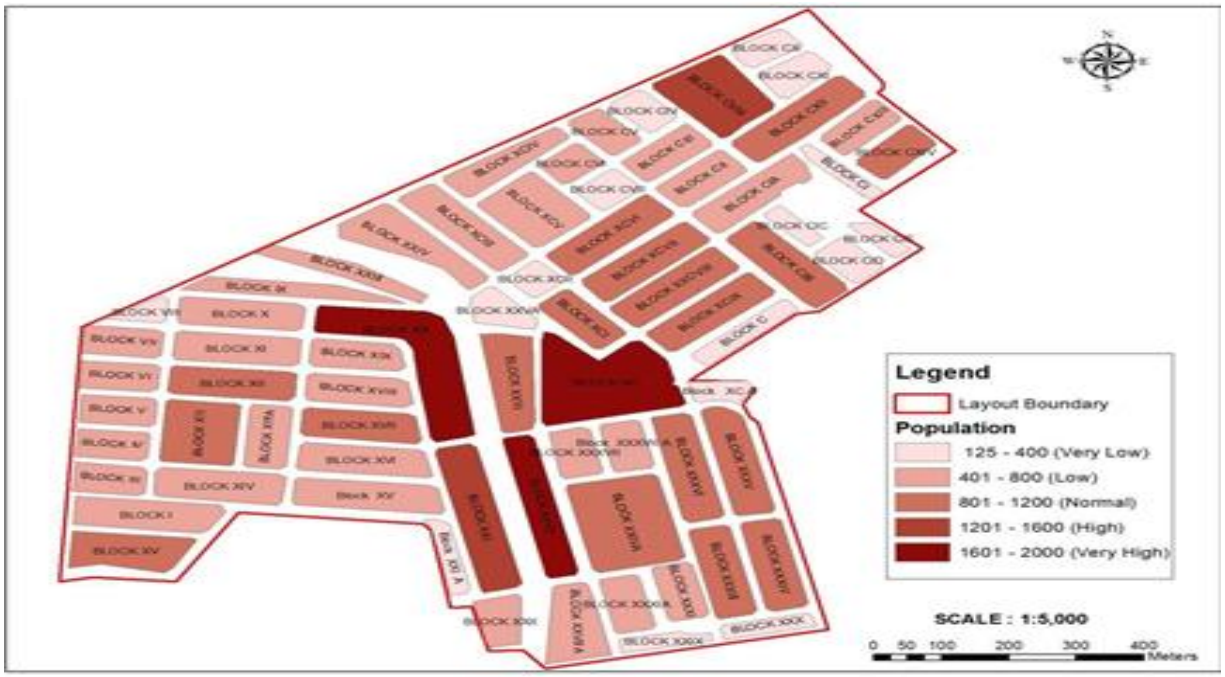

Figure 5. Map of population concentration by block in Achara Layout

The map of population by block shows high concentration of the population along major road in Achara Layout (Agbani road). It can be attributed to a combination of factors that have shaped the urban development patterns in the area. From the survey carried out the noticeable justification for the high population concentration along major road is the accessibility and convenience they offer. This major road often serves as vital transportation arteries, connecting Achara Layout to other parts of the city and facilitating movement within the neighbourhood. The proximity it provides residents with easy access to transportation networks, including bus stops, taxi stands, and other commercial outlets are particularly attractive for individuals who rely on daily commuting or require convenient transportation options for work, education, or other activities.

6. Discussion

The invention of automobile has helped to improve comfort, convenience and enhance standard of living among city dwellers. However, the advantageous intents it originated with from inception is gradually fading away as time go by and its undesired negative footprints are rapidly surfacing as a city problem to be solved. The effects of automobiles use on city life comprise; Large expanse for Parking land use, high cost of Traffic Control, more space allocation for Filling Stations and Other automobile related Services, high rate of urban Sprawl, spring up of many businesses on Roadside, degradation of the Environment, reduced exercise and recreation etc. Given the present condition of the road infrastructure, one of the most noticeable impact and trace of increased automobile use in Enugu urban (achara layout) is congestion of traffic. Every city dweller in Enugu knows and avoid the route of Agbani road at peak periods of 8am-9am, 11am-12noon and 5pm-6pm (as shown in the results) on a daily basis because of the heavy traffic build-up at Mayor, Amechi and Amuokwe junctions (bus stops). All these road intersections have traffic and streetlights but due to lack of proper maintenance coupled with the pressure they are subjected to on daily basis, it has all gone bad. To complement this, from daily observation about 15 road traffic marshals are assigned to man these busy junctions for 16 hours a day.

Achara Layout residents have long been concerned about traffic congestion within their environs that is why it is one among the roads the state government has mapped out to create a pedestrian overhead bridge. The survey findings reveal a notable traffic volume, with a recorded count of 22,178 automobiles serving a population of 112,321 individuals in the neighbourhood. This observation highlights a relatively high level of automobile ownership or usage, suggesting that approximately one in every four residents in the area owns or drives a car. This situation breeds criminal activities of car theft and

accessories burgling at night. The typical urban street grid system adopted only intensifies the traffic pressure on collector roads, as the street and road network tend to converge traffic to the layout's center and exit.

Results of the study also present the highest number of automobiles plying the layout by traffic count to be the tricycle with 8685 numbers by volume. The finding supports the work of [26] on modal split in Enugu metropolis. This implies that since the ban of motorcycle use on city roads the only alternative that best complements the merit of motorbike is the tricycle. It signifies that there is a need to return to our root means of mobility- cycling and walking but in a more sustainable manner. To achieve this objective, the first and foremost step is to reconfigure the transportation network and infrastructure, and tailor it to accommodate a walking and cycling city. As deduced from the analysis of the landuse map in figure 4, the floor area ratio of transportation to residential built-up area is 1:2 and this transportation infrastructure do not contain walking or cycling lane as seen in figure 6. This reveals the extensive road design to accommodate automobile at the expense of pedestrian and cyclist. From physical measurement, the average road width within the layout is 7.6 meters, all with flexible road pavement and dedicated solely for automobile use. Furthermore, the growing reliance of automobile as means of mobility in the layout creates parking space inadequacy and leads to double-sided off lane parking along the local roads as shown in figure 6, ultimately contributing to the narrowness of road. This observation agrees with research of Echendu et al. [27] that examined the difficulties in maintaining a free flow of traffic in Enugu city and revealed that most roads in and within the city are narrow. Furthermore, this is consistent with previous studies of Okeke et al. [26,28] who attributed traffic and transportation problem in Enugu urban to be as a result of urbanization and over dependency on automobiles.

Figure 6. Street parking on double side in Achara Layout

Ideally, the street roads in Achara layout are supposed to be planned according to design Standards and Guidelines for Streets Sidewalks, Bikeways and Access ways as depicted in the figure 7. This is to accommodate all types of road users as obtainable in developed cities roads like in the UK. Street design approach like the “Pro-Poor” design strategy should be encouraged and implemented. Policies that support active transportation plans and would offer discounts on public transportation fares for cyclists or providing financial incentives for employees who choose to walk or cycle to work should be pursued by the government. Bike-sharing programs and safe routes to Schools should be accommodated in the master plan design of new residential suburbs with the collaboration stakeholders.

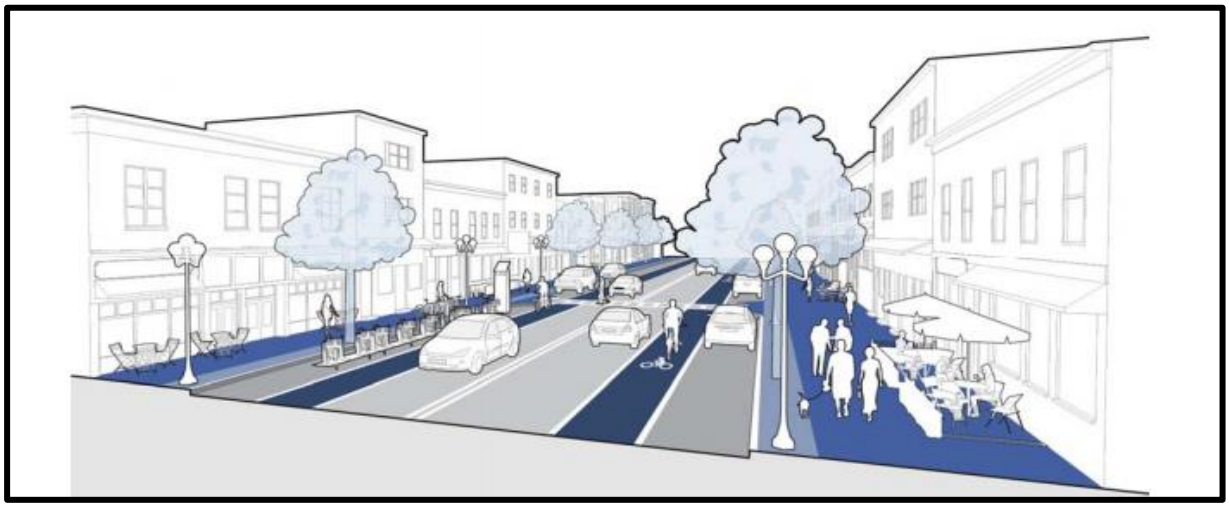

Figure 7. design Standards for layout Streets

However, this is not the case in the study area. City planners are sometimes unaware that developing and expanding roads to reduce congestion and/or increase traffic speeds would encourage increased automobile use [4]. It is worthy of note that Traffic jams were not invented by automobiles. According to Martin [29], the automobile as a technology, did not create contemporary traffic problems any more than the use of horses did in nineteenth-century cities; rather, the problem is the overuse of the automobile and the accommodation of social space to it as a homogeneous system of mobility. Traffic congestion results in both excessive energy consumption and economic productivity loss. However, to cater for the already existing deficiency, a design proposal is hereby put forward. The design target is to safely and effectively accommodate all modes of travel, and priority is given to the most vulnerable users. The hierarchy include:

- people walking
- people biking
- people on mass transit
- people driving

Having an average road width of 7.6meters pavement dedicated to automobile, it is suggested for a redesign and inculcate the most vulnerable road users. The sketch in figure 8, illustrates the proposal.

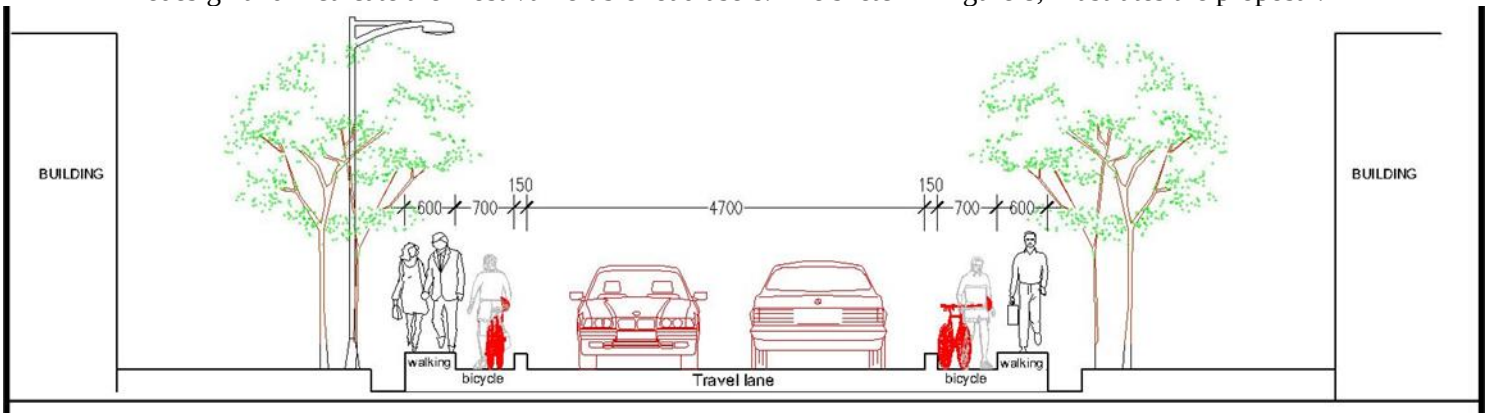

Figure 8. shows proposed Street design for Achara Layout

Conventionally, 3.6meters (12 feet) has been the common width for motor vehicle travel lanes. However, 3meters (10-foot) lanes are appropriate where speeds are 45 mph or less [30]. But from the figure above it is less than 3m (10-foot) this is because it is critical to reduce travel lane widths in order to free up additional roadway space for other users. Motor vehicle speeds are also affected by travel lane width, as motorists tend to drive faster in wider lanes and slower in slimmer lanes. Narrower lane widths have the following advantages:

- lower speeds, improving overall user safety.
- fewer, less intense crashes for all users.
- reduced crossing distance for pedestrian.
- minimize roadway footprint, leading to enhanced land use and reduced water runoff.

The figure 8 above made provision for walking and cycling and aims to discourage automobile use as it is not eco-friendly. 5m has been provided as travel lane for automobile and 1.4m for cyclist with 1.2m for pedestrian. This is to remedy the existing unsustainable road design. With the adoption to a walking and cycling city, numerous benefits abound which include:

- *Economic*; public transit, walking and cycling city has the advantage of reduction in long-term health care related cost; collision related expenses; fuel, repair and maintenance cost to users; road construction, repairs and maintenance cost; minimize economic lost in productivity due to traffic congestion etc.
- *Recreation and Health*; Cycling and walking are enjoyable, convenient, and inexpensive forms of recreation and physical activity. According to studies conducted by the National Collaborating Centre for Environmental Health [31], Individuals who engage in active transportation demonstrate a higher level of physical fitness, a lower prevalence of obesity, and a reduced risk of cardiovascular disease. The study submits that, the most effective fitness exercises are moderate in intensity, personalized, and integrated into the everyday routines.
- *Transportation*; Besides being a means of physical exercise, walking and cycling are also transportation means that is reliable, inexpensive, eco-friendly and accessible. The broader advantages of other sustainable alternatives of transportation involve: reduced traffic congestion and GHG emissions; improved infrastructure, such as lesser cost of operation/maintenance; and enhanced travel safety.
- *The effects of climate change can be reduced*; Motor vehicles, highways and car parks are significant causes of environmental damage. Reducing vehicle dependency through facilitating alternative transport opportunities such as walking, cycling, and mass transit; results in more compact subdivisions that make better use of land resources available.
- *Tourism*; cycling and eco-tourism demand is gaining widespread recognition in developed nations. The demand comes from a growing desire to explore new areas through an active mode of transport and experience one's natural environment. Cycling and active tourism growth has a direct effect on the local economy of a city or geographical area, taking into account all expenses connected with these trips, along with hospitality-related costs that might also accumulate over a period of time.

One of the key aspects of improving an all-inclusive mobility is the development and maintenance of safe and accessible infrastructure. This includes the creation of well-designed sidewalk, crosswalk, and pedestrian friendly pathways that prioritize the safety and convenience of pedestrians. Consequently, the establishment of dedicated bicycle lanes and bike-sharing programs can encourage more people to choose cycling as a viable mode of transport. Also, in promoting pedestrian and bicycle activity the provision of amenities and services that cater for these modes of transport is essential. This can include the installation of bike racks, secure storage facilities, and bike repair stations to support cyclists. Pedestrian-friendly features such as benches, public restrooms, and drinking fountains can also enhance the walking experience and encourage people to choose walking as their preferred mode for mobility. Furthermore, initiatives aimed at raising awareness and educating the public about the benefits of pedestrian and bicycle travel can play a crucial role. By promoting these modes of transport as attractive alternatives to driving, cities can shift the mindset and behaviour of residents towards more sustainable transportation options.

7. Conclusion and Recommendation

From the study, it could be concluded that the transport industry has an influencing capacity and a has a significant role in making our cities become more sustainable. The concept of a paradigm shift in urban transportation is increasingly gaining traction in numerous developed cities worldwide. This shift is driven not only by the imperative to decarbonize the fuel supply but also by the vision of creating future

cities that are characterized by enhanced cleanliness, economic viability, and social equity. Reducing motorized traffic and turning to non-motorized modes of transportation has enormous Economic, health, Transport, environmental and social benefit. However, it should be noted that even the most innovative ideas for fostering sustainable mobility and urbanism will fail in the absence of political will and administrative frameworks to adopt and implement them.

Figure 9. Street design hierarchy

The study has shown that the city of Enugu faces a significant challenge in terms of its transport urban infrastructure, which is predominantly designed and optimized for motorized traffic while neglecting the needs of pedestrians and cyclists. Mobility for a sustainable future will be dependent on a shift in perception and a re-ordering of priorities. It calls for a "Pro-Poor" design strategy. This entails designing to create a high-quality, secure settings for biking and walking incorporating a pattern of mixed land-uses that enables the very urban poor to allocate income to their pressing needs, thereby aiding poverty reduction. Transportation system planning should begin by prioritizing pedestrians and cyclists as shown in the figure 9. Sustainable complete streets design as recommended creates a comprehensive network to accommodate all users, depending on the context and purpose of the road.

References

[1] United Nations 2018 Revision of World Urbanization Prospects, New York. Retrieved from https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html accessed 3/16/2020
[2] Lagan C and McKenzie J 2004 Sustainable Cities, Sustainable Transport. Earth Trends. Retrieved from http://earthtrends.wri.org. accessed 2/14/2020
[3] Steg L and Gifford R 2008 *Sustainable Transport and quality of life. Obstacle, Trends and Solutions*. In Building Blocks for sustainable Transport. **1** 183-202. Emerald Publishing Limited
[4] Okeke F O, Okosun A E, Udeh C A and Okekeogbu C J 2020 Cities for People: The Dependency & Impact of Automobile in the Life of City Dwellers. *Euro. J. of Sust. Dev*. **9.** 3 pp 157-178 doi: 10.14207/ejsd.2020.v9n3p157.
[5] Cervero R 2013 *Transport Infrastructure and the Environment: Sustainable Mobility and Urbanism*. Paper prepared for the 2nd Planocosmo International Conference Bandung Institute of Technology, October 2013
[6] Aluko O K 2018 Lack of cycling and pedestrian facilities as impediments to sustainable transport in Lagos, Nigeria. Global Sci. J. **6.** 7 pp 7-14.
[7] United Nations Secretary-General's High-Level Advisory Group on Sustainable Transport 2016, *Mobilizing sustainable transport for development analysis and policy recommendations*. Retrieved from.https://sustainabledevelopment.un.org/content/documents/2375Mobilizing%20Sustainable%20Transport.pdf accessed 3/11/2020
[8] United Nations Human Settlements Programme 2015 *Habitat III Issue Paper 19* – Transport and Mobility Retrieved from www.europeanhabitat.com/wp-content/uploads/2016/03/19_ Transport-and-Mobility.pdf. accessed 3/19/2020

[9] Okeke F O 2021 *Analysing the Role of Architects in Achieving the Sustainable Cities Goal by 2030* In University-Led Knowledge and Innovation for Sustainable Development. Edited by F. A Anyogu, C.A Eme, J. A Ogbodo published by Boldscholar Research Ltd. Abuja, Nigeria Pp. 104-112
[10] Okeke F O, Chendo I G and Sam-amobi C G 2019 Resilient architecture; a design approach to counter terrorism in building for safety of occupants, *IOP Conf. Series: Material Sci. and Eng*. **640** (012003) pp 1-17 doi:10.1088/1757-899X/640/1/012003.
[11] Pourbaix J 2011 Towards a smart future for cities: urban transport scenarios for 2025. *Public Transport International*, **60**. 3 pp. 8-10.
[12] OCASI 2015 *What are the health benefits of walking and cycling?* Ontario Council of Agencies Serving Immigrants Retrieved from https://settlement.org/ontario/daily-life/transportation/walking-and-cycling/what-are-the-health-benefits-of-walking-and-cycling/ accessed 3/11/2020
[13] Jain A K 2011 *Sustainable urban mobility in Southern Asia. Nairobi*: UN Habitat. Retrieved from http://www.unhabitat.org/grhs/2013 accessed 3/3/2020
[14] Gakenheimer R and Dimitriou H 2011 *Introduction*. In: Urban Transport in the Developing World: A Handbook of Policy and Practice, H. Dimitriou and R. Gakenheimer, eds. Cheltenham UK: Edward Elgar, pp. 3-7.
[15] International Energy Agency 2011 *Key world energy statistics*. Brussels. IEA. Retrieved from http://www.iea.org/textbase/nppdf/free/2011/keyworldenergystats.pdf accessed 3/3/2020
[16] Okeke F O, Eziyi I O, Udeh C A and Ezema E C 2020 City as Habitat: Assembling the fragile city. *Civil Eng. J.* **6.** 6 pp1143-1154. doi: http://dx.doi.org/10.28991/ cej-2020-03091536
[17] Wright L and Fulton l 2005 Climate change mitigation and transport in developing nations', *Transport Rev*, **25.** 6 pp 691-717.
[18] UN Habitat, 2011. *Global report on human settlements 2011*: cities and climate change. Nairobi.
[19] Okeke F O, Okeke F I and Sam-Amobi C 2019 *Building collapse in Nigeria and development control, the missing link*. In. Laryea, S. and Essah, E. (Eds) Procs West Africa Built Environment Research (WABER) Conference, 5-7 August 2019, Accra, Ghana, pp 242-256
[20] Okpalike C, Okeke F O, Ezema C E, Oforji P I and Igwe E A 2021 Effects of Renovation on Ventilation and Energy Saving in Residential Building. *Civil Eng. J.* **7** pp 124-135. http://dx.doi.org/10.28991/CEJ-SP2021-07-09
[21] Okeke F O, Sam-Amobi C and Okeke F I 2020 Role of local town planning authorities in building collapse in Nigeria: evidence from Enugu metropolis. *Heliyon* **6.** 7 https://doi.org/10.1016/j.heliyon.2020.e04361
[22] National Population Commission of Nigeria (NPC) *2006 Federal Republic of Nigeria, National Bureau of Statistics* available online at https://www.citypopulation.de/php/nigeria-admin.php?adm1id= NGA008 accessed on the 01/03/2020.
[23] Malthus T R 1830 *A summary view of the principle of population.* J. Murray.
[24] Nnam V C, Okeke F I and Anejionu O C D 2011 *Implementation of a Multipurpose Cadastre in Nigeria: A Case Study of Achara Layout, Enugu State.* 46th Annual General Meeting & Conference, Nigerian Institute of Surveyors,13th -17th June 2011. Calabar, Nigeria
[25] Ozoekwe, C I 2015 *Application of remote sensing and GIS in the population study of Achara Layout Enugu, Enugu State, Nigeria*. A published MSC thesis submitted to the Department of geoinformatics and surveying, University of Nigeria, Enugu Campus.
[26] Okeke F O, Gyoh l and Echendu F I 2021 Impact of Land use Morphology on Urban Transportation, *Civil Eng. J.* **7**. 10 pp 1753–1773 http://dx.doi.org/, doi:10.28991/cej-2021-03091758.
[27] Echendu I F, Okeke F O and Nnaemeka-Okeke R C 2020 An investigation of challenges in the existing pattern of intra-city traffic in Enugu metropolis. *Tema. J. of Land Use, Mob. and Env.* **13.** 2 pp 191-208. http://dx.doi.org/10.6092/1970-9870/6097
[28] Okeke F O, Echendu I F and Nnaemeka-Okeke R C 2021 Determinants of intra-urban travel in southeast Nigeria; evidence from city of Enugu, *Transport Problem* **16.** 4 pp 185–198, doi:10.21307/tp-2021-070.

[29] Martin V M 2010 *The Automobile Shapes the City; Modifying the City Core*. Available at http://www.autolife.umd.umich.edu/Environment/E_Casestudy/E_casestudy4.htm. Accessed 23/08/2017
[30] AASHTO 2018 *A Policy on Geometric Design of Highways and Streets* 2018 7th Edition pp 1-15
[31] National Collaborating Centre for Environmental Health 2010 *Active transportation in urban Areas: exploring health benefits and risks*. Retrieved from http://www.ncceh.ca/sites/default/files/Active_Transportation_in_Urban_Areas_June_2010_0.pdf accessed 3/12/2020.