CARD International Journal of Engineering and Emerging Scientific Discovery
ISSN: 2536-7250 (Print): 2536-7269 (Online)
Volume 2, Number 4, December 2017
http://www.casirmediapublishing.com

Pedestrians Analysis and Design for Taiwo Road Ilorin, Kwara State, Nigeria

Braimoh O. S. & Gana A. J.
Department of Civil Engineering
College of Science and Engineering
Landmark University Omu-Aran, Kwara State
Email: braimoh.solomon.@lmu.edu.ng, Phildebo123@gmail.com
Corresponding Author: Gana A. J.

ABSTRACT

Designing for pedestrians is a research work carried out as a result of the inadequate availability of pedestrian facilities resulting to increased accidents and other environmental and human hazards resulting from intermodal competitions for spaces vis-à-vis Highway capacity. This has helped to consider the possibility of pedestrian facilities for transportation in Taiwo road. The presence of pedestrian in Taiwo road has been investigated and found to be 538 per hour. In this research, Pedestrian facilities were designed for the Ibrahim Taiwo road in Ilorin city which is 3900m distance (from Taiwo salee junction to the end of the road at General Hospital roundabout).The design was done by carrying out pedestrian count on the Sidewalk and Crosswalk for the road in two hours for three days. The Sidewalk designed is 2.0m while the distance between the crosswalk markings is 0.6m and the thickness of the zebra crossing line is 0.6mat 3800m, 3200m 2150m, 650m and 200m from the origin of the road with 3m width, the Island height is 0.15m, the height of the signs above the ground is 2.0m and the Bus shelters are located at 3800m and 650m from the origin. The use of pedestrian facilities is vital to the advancement and development of any locality. By placing emphasis on walking, the problem of acceptance will be over along the Ibrahim Taiwo road of Ilorin. It is recommended that the design of pedestrian facility should no longer be ignored in current transportation planning practices and in formulating, implementing and refining policies. In this light, Taiwo road should be marked with white lines for the sidewalk and other pedestrian facilities provided.

Keywords: Pedestrians, Analysis, Design, Taiwo Road Ilorin

INTRODUCTION

Man's history is invariably attached to the history of movement (Owolabi, 2010), and 'pedestrian trip' is the basic unit of travel behavior. Prior to the advent of horses, camels, bicycles, automobiles, aircrafts, ships and other motorized or non-motorized modes of transport, man has perpetually relied on translation from one place to another by walking, regardless of distance, weather and environmental factors. Hence from the few thoughts expressed above, suffice is to say that trips made by walking are referred to as 'walk trips'. Walk trips comprise the bulk of non-motorized travel in many cities (Burke and Brown, 2007). Pedestrian walk trips can be for transport purposes (so called active transport) made to access destinations or to access public transport en route to destinations (Burke and Brown, 2007). Although walk trips made for transport purposes primarily involve traveling from an origin to a target destination, it may also be for exercise, sport or recreation – when accessing a destination is not the primary purpose of a trip (Litman, 2003; Tudor-Locke *et al.*, 2005).

The dynamics of the transportation system started from the use of the walk mode to the various motorized modes that exist now, as a result of technological advancement hence space conventional planning tends to assume that transport progress is linear (Walk→ Bike →Train →Bus → Car→ Airplane) with newer, faster modes replacing older, slower modes (Litman, 2010).

In our mechanized society of today, walking retains its importance to mankind, providing an indispensable means of transportation, communication and recreation. Walking provides a method of transportation interchange and mixing of trip linkages so flexible and varied that it would be impossible to duplicate by any mechanical system. It was estimated that in the central business districts of larger cities more than 90 percent or more of all daily trips within the core area are walking trips (Morris and Zisman). With regard to communication and recreation, walking is, more often than driving, engaged in for the pure pleasure of exercise, and the intimate experience with surrounding sights, smell and sound. Walking is the true medium of the market place.

Walk trips are also a critical component of the transportation system, providing connections between homes and transit, parking lots and destinations, and within airports. Walk trips (including variations such as canes, walkers and wheelchairs) therefore can be considered the most basic form of transportation, for the following reasons:

- It is universal and highly accessible. Virtually everybody walks, and virtually all trips include walking links;
- It is very affordable; economically and socially disadvantaged people tend to rely heavily on walking for transport;
- It provides connections between other modes of transport. Automobile, transit and air travel trips all depend on walking;
- It provides additional benefits, including exercise, enjoyment, health and environmental sustainability (Litman, 2010).

The word pedestrian include all non-vehicular mobility (including the use of, for example, foot wheelchair, guide dogs or other mobility aids). Nearly all short trips could be undertaken by walking.

A pedestrian is defined as any person on foot, in a pram, or a person with disability in a non-motorized or motorized wheelchair, and includes:

- A person pushing a perambulator or wheelchair
- A person wheeling a bicycle or a wheeled toy, if the person is completely dismounted from the Bicycle or wheeled toy
- A person in or on a wheeled recreational device or a motorized scooter
- A person under 12 years of age in or on a wheeled toy

A wheeled recreational device is defined as a device used to transport a person who is propelled by human power or gravity only. The definition covers roller skates, skateboards and unicycles. All people using these devices are legally classified as pedestrians.

A motorized scooter is defined as a device with two or more wheels used by a single person and propelled by an electric motor, provided the motor is not capable of travelling at more than 10km/h on level ground and the maximum motor output is 200 watts. All people using these devices are legally classified as pedestrians.

Pedestrian walking is a type of non-motorized transportation that helps to reduce the adverse effect of motorized transportation and to enable us enjoy the benefits of walking.

Aim of the Project

The aim of the study is to design the pedestrian facilities for Taiwo Road in Ilorin city.

Objectives of the Study

The objectives of the study are to:

i. Assess the use of pedestrian facility on Taiwo road considering the benefits of these facilities to transportation system.
ii. Source for information on design for pedestrians and to show the need to design and build these facilities alongside our roads.
iii. Design pedestrian facility for an existing arterial road.

Historical Background

We begin and end most trips on foot. Yet due to a lack of attention to the needs of pedestrians, and a tendency to favor motorized transport, pedestrians are at risk of death, injury and disability on our roads. Half of the world's road traffic deaths occur among pedestrians (22%), motorcyclists (23%) cyclists (5%), 31% of deaths amongst cars and the remaining 19% among unspecified road users. 38% of all African road traffic deaths occur among pedestrians according to 2013 Global status report. 39% road traffic deaths occur among pedestrians according to 2015 global status report. It could be as high as 2000 deaths annually in Nigeria if nothing is done. 84% of the roads in low-income and high income countries where pedestrians are present carry traffic at 40km/h and above. The probability of a pedestrian being killed rises by a factor of eight as the impact speed of the car increases from 30km/h to 50km/h. older pedestrians are even more physically vulnerable as speeds increase. A 5% cut in average speed can result in a 30% reduction in the number of fatal crashes. Speed is the single most important parameter of road users in general and Non-motorized traffic in particular. According to 2013 and 2014 FRSC Annual reports, the most deadly probable factor for all road crashes is speed violation, the report noted 32% and 28% respectively as percentage of overall causative factors (FRSC, 2015).

Justification for the Study

The need for designing for pedestrian facilities is key to advancement and development in any locality. In our present world, much emphasis has been placed on car ownership and use, which has made pedestrian facilities to be relegated to the background. This has come with a lot of challenges. The use of pedestrian facilities as a means of mobility will help to meet the problem of acceptance. This project provides the design of the pedestrian facilities for Ibrahim Taiwo road in Ilorin of kwara state. This Ibrahim Taiwo road is a sample that can be looked upon and integrated into the national mobility program.

In the realm of transportation planning, a city or nationwide plan for transport is incomplete without the incorporation of pedestrian facilities, as it is also an important component of the transportation system (Owolabi, 2011). Previous researches have documented a lot of literature on travel by various modes of transport with facilities provided for their operation.

Having been spurred by the need to provide an urgent solution to these problems, this in depth study on designing of pedestrian facilities is carried out on Taiwo. This is with the view of knowing the pedestrian volume and factors affecting walking. Furthermore, walk trips are of increasing interest given the decline of physical activity observed in some Western populations (Berrigan *et al.,* 2006; Frank 2000). Germane to note is the current surge in popularity of pedestrians' walk trips in urban planning and transportation circles as a solution to the environmental and congestion issues plaguing many cities (Litman, 2010)

Indeed the benefit of active transportation are manifold: while potentially reducing traffic congestion and dearth of alternatives, human-powered transportation improves personal health, enhances quality of life, and has been linked to economic vitality in urban settings. The conventional wisdom related to active transportation – which generally refers to walk trips is that trip origins and new destinations should be brought together, facilitating easier by the mode.

This research therefore presents detailed information on designing for pedestrian on Taiwo Road derived from pedestrian traffic count along the road at peak periods. Given the general lack of attention to this form of urban travel and its attendant decline, the interest of this research is in providing quantitative information that can be potentially of use for policy formulation and transportation planning and design through a better understanding of pedestrians' walking behavior and patterns of change.

The figure 1.1 shows the AASHTO recommendation of having Sidewalk incorporated into the planning, designing and construction of city streets. Sidewalks are not supposed to be an afterthought but be part of the street.

LITERATURE REVIEW

Like other modes, walking is not but for this purpose it can be considered as a transport mode by which people and light weight goods are transited from one place to another. It is a key element in pedestrians' travel to destinations like work, school, recreation centers and local facilities. Walking comprises the bulk of non-motorized travel in many cities (Pucher and Dijkstrah 2003; Vivier 2001). Walking can be for transport purposes (so called active transport) to access destinations or to access public transport en route destinations. Walking may also be for exercise, sport or recreation- when accessing a destination is not the primary purpose of a trip (Litman 2003; Tudor-Locke et al 2005). Walking and its insitu data collection is of increasing interest given the decline of physical activity observed in some western countries (Berrigan *et al.,* 2006; Frank 2000).

Basic Pedestrian Walk Trip Data

Certain types of data are useful for designing non-motorized transportation trends and activities (ABW 2010). Performance indicators are data collected specifically to measure progress towards objectives. It is useful to establish standard non-motorized data collection procedures to allow comparisons between different locations and times.

Table 1 NHTS Trip Attributes (Weinstein and Schimek 2005)

Purpose	**Frequency (percent)**	**Mean distance(km)**	**Mean distance(km)**	**Duration (minutes)**
Personal business/shopping/errands	48%	0.71	0.35	11.9
Recreation/exercise	20%	1.88	0.91	25.3
To transit	16%	N/A	N/A	19.6
To or from school	7%	1.00	0.54	13.3
To or from work	4%	1.26	0.41	14.1
Walk dog	3%	1.15	0.41	19.0
Other	2%	0.92	0.36	14.8
Total	100%	1.10	0.41	16.4

Source: Weinstein and Schimek (2005)

Table 2.1 lists some types of data that are useful for pedestrian transport design. Some of these data might have already been collected; others will require new data collection activities. Some of these data will be subjected to analysis during the course of this research. Note however, that conventional travel surveys often undercount non-motorized travel, particularly walking links of motorized trips, as will be described later in this research, so improved travel survey methods may be needed. "Disaggregation" describes how this data should be classified.

In a detail baseline survey of adults residents in the U.S communities performed before major non-motorized improvements were implemented, Krizek et al (2007) found that on a given day, 15% to 35% of adults in the surveyed communities walked for transportation, while 2% to 4% bicycled. The average daily walking distance for those who did walk for transport is 1.5 to 2miles, while cyclist rode an average of 5 to 8 miles. About 30 to 40% of bicycle or walking commute trips and about 95% of non-motorized trips to other destinations would otherwise have been made by driving. They estimate that walking and cycling reduce approximately 0.25 to 0.75 mile of daily driving per adult resident, or 1-4% of total automobile travel. Some of this motorized travel would be ridesharing, in which passengers use an otherwise empty seat in a vehicle that would make the trip anyway, but others generate additional vehicle travel, including some chauffeured trip in which a driver makes a special trip to carry a passenger, which often generates an empty return trip.

Transportation surveys such as the National personal transportation survey (transportation statistics) provides information on non-motorized travel. Rossi (2000) describes technical information on non-motorized demand models developed in the Boston, Portland and Philadelphia regions. University of North Carolina (1994) and Clarke and Tracy (1995) summarize data from various communities, and discussion of factors that affect walking and cycling activity. Dessyllas *et al.*, (2003) used multiple Regression Analysis to model pedestrian travel (Trip generators), street network connectivity and transport accessibility (proximity to tube station and other transport terminals). McDonald et al (2007) developed a model for predicting non-motorized travel demand and the impact that on and off-road walking and cycling facilities will have on the use of these modes.

Schneider, pattern and Toole (2005) described non-motorized travel surveys used in various communities, including manual count, automated count survey targeting non-motorized users, survey sampling a general population, inventories and spatial analyses. Cao Handy and Mokhtarian (2006) used a travel survey performed in Austin, Texas to evaluate the effect of land use patterns on strolling trips (walking for pleasure or exercise) and utilitarian walking trips. They found that the pedestrian environment at the origin (home) has the greatest impact on strolling trips, while the pedestrian environment at the destination appears to be at least as important for utilitarian trips. They also found that people are more likely to stroll around or walk to the store when fewer vehicles are on residential and commercial streets. They found that strolling accounts for the majority of walking trips, and tends to be undercounted.

Petristsh *et al.*, (2008a and 2008b) developed models for predicting the increase in walking activity, reduction in motorized travel, and resulting health and energy conservation benefits likely to results from walking facility improvements. They find that a walking network's overall quality has a greater influence on the volume of walk trips in an area than that any specific facility, indicating significant network effect. In a detailed literature review, Puncher, Dill and Handy (2010) concluded improving walking infrastructure (path and sidewalks) do tend to increase walking activities, although the impact are often small and vary depending on the specific types of improvement and addition support factors.

Research Trend

Until the mid-1990s, pedestrian behavior was largely ignored in the transportation and planning literature. In the last decade, especially the last five years, the topic has suddenly become popular and, any study about pedestrians has been published or are underway. Much if the new literature has come from the public health community, complementing work done by planning and transportation researchers. Despite this outburst of activity however, little of it has been documented walk trips and there is also little consensus about which environmental factors influence pedestrian most.

There has been the attention in the literature to influence distance (or proximity) on trip generation rates and modal choices for walking Johnson,(2006); Polzin and Maggio (2007) as well as to walk trip distances travelled to particular destinations, for instance, Hsiao et al, (1997:51) used to show that person walked on average 0.29 miles (0.47km) per trip to or from public transport. Plaut (2005:351) used data in 2001 American Housing Survey to determine how far people walked from home to work places as part of single mode-trips

The Bicycling and Walking Benchmarking report (ABW 2010) summarizes current walking and cycling activity in the U.S by city and state and provides data form other countries based on various sources. Weinstein Schicmek (2005) discusses problems of obtaining reliable non-motorized information in conversation travel survey, and summarizes walking data.

In the U.S. 2001 National Household Travel Survey (NHTS), They find that about 10% of the total measured trips involved non-motorized travel (about 16% of this walking trips were to access public transit), making walking the second most common mode after automobile travel. Overall, people average 3.8 weekly walking trips, but some people walk much more than others. About 15% of the respondents report walking on a particular day, and about 65% of the respondents reported walking during the previous week. The median walk trip took 10minutes and was about one-quarter mile in length, much less than the mean walking trip (i.e a small number of walking trips are much longer in time and distance). Table 2.1 summarizes the walking trip data.

They reached the following overall conclusion about U.S walking activity:
Most Americans walk very little. The vast majority (48%) reported no walk trips in their daily diaries. More than one-third reported no walk trips within the previous week.

Exercise and recreational trips account for more than one quarter of walk trips, a significant share. Because these averages twice the distance of other walk trips, they account for about half share of the total distance walked. However, the determinants of exercise trips are completely different from those of utility walk trips.

Transit access trips are significant component of total walking comprising 16% of all walk trips. This finding suggests that improving the pedestrian environment might be an important component of making transit more attractive and that increased transit use could significantly increase daily physical activity.

The mean trip distance for utility walk trips, 0.5miles, was remarkably constant across many demographic groups and in different neighbourhood densities. This may suggest that it is reasonable for planning purposes to take this figure of half a mile as a maximum that many Americans would be walking to work in ordinary circumstances.

For those who walk, walking can make a significant contribution to the Surgeon. There is General suggestion of at least 30 minutes of daily exercise. Respondents who walked to transit averaged 26 minutes per day (2.0 trips * 12.8 minutes/trip) and those who walked or jogged for recreation averaged 41 minutes per day (1.6 trips *25.7 minutes/trip) and those who walked for other purpose averaged 28 minutes per day (2.2 * 12.5 minutes/trip). Increased land use density by itself has only a modest impact on walking activity compared with other factors.

The UK National Travel Survey

(NTS) and the US National Household Travel Survey (NHTS) attempt to collect more comprehensive data on non-motorised travel. The NHTS indicates that about 12% of total trips are by non-motorised modes. Walking and cycling represent a relatively large portion of shorter trips, as illustrated in table 2.3.More than half of trips of a mile or less, and nearly a third of trips of three miles or less are by walking or bicycling.

Table 2 Shorter Trip Mode Share (Litman 2010, based on NHTS 2009)

Trip Distance	**Portion of Total Trips**	**Walk**	**Bike**	**Transit**	**POV**	**Totals**
0.5 or less	10%	61%	3.1%	1.5%	34%	100%
1.0 or less	19%	51%	3.3%	3.0%	42%	100%
3.0 or less	41%	27%	2.2%	3.9%	67%	100%

This table summarize mode share of shorter trip distance categories.

Source: Litman 2010, based on NHTS 2009

Many of these shorter trips are link in longer trips, including a series of automobile trips to multiple destinations when running errands, walking to and from transit stops, and walking a few blocks to and from a parked car. Rietveld (2000) finds that the actual number of non-motorized trips is six times greater than what conventional surveys indicate. Similarly, in Germany only 22% of trips are completely by walking, but 70% include some walking (Brog, Earl and James, 2003).The Southern California Metropolitan Transportation Authority increased the portion of non-motorised travel in their models from about 2% of regional trips (based on conventional travel surveys) up to about 10% in response to the more comprehensive travel data provided in the 2001 National Household Travel Survey (www.bts.gov/nhts). This obtained more detailed information on walking trips than more than reported in the 1995 National Personal Travel Survey (NPTS) which used more conventional survey methods. Chu (2003) used NPTS data to calculate average minutes walked by various demographic groups.

Besser and Dannenberg (2005) used the 2001 National Household Travel Survey to analyse the amount of walking associated with public transit trips, and factors that affect this activity. They found that Americans who use public transit on a particular day spend a median of 19 daily minutes walking to and from transit .In multivariate analysis, rail transit, lower income, age, minority status, being female, being a non-drivers or zero-vehicle household, and population density were all positively associated with the amount of time walking to transit.

(Owolabi, 2010) reported a 6% modal split proportion of walk trips in Akure metropolis. This represents a very small proportion compared to other modes, although walking was not of major concern. It is the aim of this research to really obtain complete and reliable information on the walk trips volume in Taiwo Road of Ilorin metropolis without ignoring and undercounting shorter trips, trips to access motorized modes and so on. Fall outs and limitations of previous research will be given serious consideration.

To their credit, many transportation professionals give non-motorised transportation more consideration than what is implied by the available travel survey data. They realize that non-motorized travel has many critical functions in an efficient and balanced transportation system, some of which are difficult to measure. However, this occurs in spite of, rather than supported by conventional transportation data analysis. There is so much that can be done to improve transportation planning and modelling to better design non-motorized transportation.

Information on current walking travel can be gathered in the following ways (IHT 2000; price 2001): Travel surveys can be designed to elicit sufficient response concerning non-motorised travel. For example, "travel" should be clearly defined to include walking trips. Short, non-work and recreational trips and trips by the children should be counted.

A special survey targeting pedestrians (such as survey forms distributed through sport clubs, recreation centres, colleges and schools). Surveys can be handed out to pedestrians as they travel along a street path. Surveys should include special user groups, such as people in wheelchairs and elderly pedestrians; particularly in areas they are frequent.

Traffic counts that gather information on pedestrian's travel; these can include photoelectric counters installed on trails, electronic counter installed on paths and sidewalks and manual counts. Volunteers from pedestrian organizations may also be mobilized to perform manual counts for non-motorized travel. Surveys should gather the following information on non-motorized travel.

Table 3 Factors Affecting Pedestrian Travel

Features	Definition	Indicators
Network quality	Whether sidewalks and paths exist, and connect throughout an area	Portion of streets with non-motorised facilities. Network connectivity and density (kilometre of sidewalks and sidewalks and paths per square kilometre)
Network quality	Whether sidewalks and paths properly designed and maintained.	Sidewalk and path functional width. Portion of sidewalks and paths that meet current design standards. Portion of sidewalks and paths in good repair.
Road crossing	Safety and speed of road crossing.	Road crossing width. Motor vehicle traffic volumes and speeds. Average pedestrian crossing time. Quantity and quality of crosswalk, signals and crossing guards.
Traffic protection	Separation of non-motorized traffic from motorized traffic, particularly high traffic volumes and speeds.	Distance between traffic lanes and sidewalks or paths. Presence of physical separators, such as trees and bollards Speed control
Congestion and users conflicts.	Whether sidewalks and paths are crowded or experience other conflicts.	Functional width of sidewalk and paths. Peak period density (people per square meter). Clearance from hazards such as street furniture and performer within the right-of-way. Number of reported conflicts among users. Facility management to minimize users' conflict.
Topography	Presence of steep inclines.	Portion of sidewalks and paths with steep inclines.
Sense of security	Perceived threats of accidents assault, theft or abuse.	Reported security incidents Quality of visibility and lighting.

MATERIALS AND METHOD

Data Collection: Manual Method of Field counting

Manual counting is the method that has been used in this project. Walking pedestrians are counted by an enumerator using the tally counting method. The result is recorded on a specially prepared form as shown in figure3.1. The size of the data collection team depends on the length of the counting period, the type of count being performed, the number of lanes or crosswalks being observed, and the volume level of traffic (Robertson, 1994). The number of personnel needed also depends on the study data needed.

The duration of counts depends on the purpose for which the data are needed and the financial and man power resources at the command of the traffic Engineer. For this research work, the short term duration count is used. Short term count is meant to determine the peak hour traffic volume and it is usually for one hour (1hr). Peak hour volumes are taken twice a day for three days. Counts have been conducted during the time periods of **2-hour.** All of pedestrian counts are two-hour counts conducted from 8:45-9:45a.m and 3.45-4.45pm. (Simon Blenski at 612-333-1274 or simon.blenski@minneapolis). The counts focus on recording individuals, not conveyances. For example, if an individual crosses the line multiple times, he or she is counted each time.

Sampling Procedure

The study area, Ibrahim Taiwo Road, is a commercial and medium density zone. In this design of pedestrian facilities, Sidewalk and crosswalk shall be considered .A pedestrian count is to gain an understanding of pedestrian travel and to help facilitate data collection, analysis and Design.

OPERATIONS AND METHODOLOGY

Ibrahim Taiwo is a double lane with a central raised median of width 2m, carriageway width of 7.5m and shoulders of 1.5m on each side of the median; hence the road is 20m wide. Taiwo road has a length of 3900m. The manual method used to carry out pedestrians count to obtain the sidewalk and crosswalk pedestrian volume demand with the pedestrian count form at hand. The equipment/materials used are: pencil, eraser, a blank field paper sheet, hand tally counter, stop watch, a tape rule and a clipboard.

The volume of pedestrian along the sidewalk is determined as well as the pedestrian volume of cross walking for duration of one hour in the morning and one hour at evening. The data in Table 3.1 shows the volume of pedestrian per hour for sidewalk and crosswalk in other to get data with which the pedestrian facilities can be designed. The average pedestrian volume is 538ped/hr. This enables the design of Sidewalk, Crosswalk, refuge Island, Bus shelter, Mid-block, and Signs to be properly designed. It is germane to note that the Median and the Lighting have been designed on the Taiwo road and as such need not be redesigned (Robertson, 1994).

Traffic data: The data used in designing is usually a future forecast on the basis of existing traffic count and expanded on the basis of normal expected growth in the area or enhanced by estimates of future business, commercial or residential development. Most non-motorized transportation geometric pavement designs based on what traffic demands will be 20 years from the current year (www.onlinemanuals.txdot.gov)

Study date: ____2016__ Time: from: __8:45am__ to: _9:45am__Location:_Taiwo Road____Crosswalk Across: ___________________________Curb-to-curb or road width *W*: 20m______

Divided roadway? **Yes** No

Width of island: _2m____________________

Time	Pedestrian Crossing	Pedestrian Side walking.	Time	Pedestrian Crossing	Pedestrian Sidewalking .
8.45 to 9.45am	211per hour	323 per hour	3.45 to 4.45pm	90per hour	310per hour
8.45 to 9.45am	141per hour	376per hour	3.45 to 4.45pm	232per hour	216per hour
8.45 to 9.45am	215per hour	530per hour	3.45 to 4.45pm	182per hour	412per hour

Figure 3: Pedestrian count data

DESIGN OF THE PEDESTRIAN FACILITIES

Pedestrian Volume

In addition to the volume of traffic actually measured at any pedestrian count, allowance should be made for an increase in traffic volume on account of: The normal growth in the number of registered pedestrians from year to year and the change in traffic arising out of alterations in land use and the development of land served by the road.

Having taken all the factors above into consideration to access the expected volumes of traffic using the road at some future date (design year), it is assumed that it would be uneconomical to provide sufficient capacity to meet the volume occurring once or twice a year, therefore, a lower volume is selected as the design volume.

Design Pedestrian Volume for Sidewalk

The critical variable to determine for sizing pedestrian Sidewalk is the flow rate in pedestrians per minute.

$v = S/M$

Where:

v = flow or volume;

S = speed; and

M = pedestrian area module ("space") = 1/density. (*Fruin, 1971*):

$S = 1.5m/s$, Density = $1.5ped/m^2$ (www.help.anylogic.com)

$M = \frac{1}{1.5} = 0.6667m^2$

$V = \frac{1.5}{0.6667} = 2.25ped/sec$

Spacing for Sidewalk

$T_0 = 0.37(W_a+W_b) +1.4$ (Fruin, Ketcham and Hecht's, 1988)

T_0 = circulation time (sec)

W_a+W_b = intersecting sidewalk width (meters).

$T_0 = 0.37(1.8+1.8) +1.4$

$T_0 = 1.332 +1.4$

$T_0 = 2.732m$

The Design Speed

The design speed for pedestrian is 1.2m/s to 1.8m/s depending on the factors:

(a) Age of the pedestrian (b) Congestion due to lane width.

Average Design speed is $\frac{1.2+1.8}{2} = 1.5m/s$

Posted speed = 85 % of the design speed.

Posted speed =0.85x1.5 = 1.275m/s

Design of Pedestrian Sidewalk Lane Width

The critical size for walkways is the usable width. The minimum width is 1.5m to allow two people to walk comfortably side by side. This minimum width is usually inadequate in areas with two-way traffic and/or heavy use. The critical variable to determine for sizing pedestrian walkways is the flow rate in pedestrians per minute.

From the flows at peak periods, which are determined in pedestrians per hour, this number is divided by speed in metres per hour (4104 metres/hr or 1.14m/s) to calculate the space requirements per pedestrian (this result is in square metres). To determine the final width divide by either 0.6 metres (the width of the body ellipse from figure 1) or0.75 metres (half the recommended with for two people walking side by side). If the resulting figure is less than 1.5 metres then you should make the sidewalk 1.5 metres.

In this case where the sidewalk parallels a view (in other words where pedestrians may be stopping to take pictures or to stop to look at a view or interpretive

Counts were taken over 2 hours during peak travel time, generally

sign, provision is made for this behavior by increasing the overall width of the walkway by 0.5 metres. (Robert M.I. 2002)

Design of Crosswalk Delay

Delay, d_2 $=P_d$ $(0.75c\text{-}w)^2$(Pretty, 1979)

P_d = pedestrian volume across two streets, ped/h

C = Cycle length, s

W = walking time, s

d_2 = Total delay to pedestrian crossing

$$d_2 = 323(0.75 \times 40 - 20)^2$$
$$= 323(30-20)^2 = 323(10)^2$$
$$= 32300 \text{sec}$$
$$= \frac{32300}{60\times60} = 8.9722hrs$$

$d^1 = \frac{p}{2c}$ $(c\text{-}w)^2$, $= \frac{323}{2\times40}$ $(40\text{-}20)^2$ (Pretty, 1979)

$$d_1 = 4.035(20)^2 = 1615 \text{sec}$$

$d^1 = \frac{1615}{3600} = 0.45$hr

RESULTS AND DISCUSSION

Ibrahim Taiwo is a double lane with a central raised median of width 2m and Carriageway width of 9m on each side of the median (total road width is 20m). Taiwo road has a length of 3900m.The road is shown in figure 4.3 and figure 4.4.Lighting is already properly designed for on this road as well as the median.

coinciding with opening and closing times from school (8.45am-9.45am and 3:45 – 4:45pm).

Counts taken earlier in 2016 for Taiwo road are provided. Results are shown below.

First hour Count (morning):
Number of pedestrians cross walking = 211/ hour
Number of pedestrians side walking =323/ hour
Second hour Count (evening):
Number of pedestrians cross walking = 90/ hour
Number of pedestrians' side walking=310/ hour
Third hour Count (morning):
Number of pedestrians cross walking =141/ hour
Number of pedestrians' side walking=376/ hour
Fourth hour Count (evening)
Number of pedestrians cross walking =232/ hour
Number of pedestrians' side walking =216/ hour
Fifth hour Count (morning):
Number of pedestrians cross walking =215/ hour
Number of pedestrians' side walking =530/ hour
Sixth hour Count (evening):
Number of pedestrians cross walking=182/ hour
Number of pedestrians' side walking=412/ hour

	AM	PM	**Total**
Day 1. Pedestrian sidewalk	323	310	**633**
Pedestrian Crosswalk	90	211	**301**
Day 2. Pedestrian sidewalk	383	216	**599**
Pedestrian crosswalk	210	232	**442**
Day 3. Pedestrian sidewalk	376	510	**886**
Pedestrian crosswalk	141	222	**363**
Total	**1523**	**1701**	**3224**

Average pedestrian count 3224/6 =537.3

The histogram and graph in figure 4.1 and figure 4.2 respectively shows the plot of volume of traffic against time. Figure 4.1 is a histogram plotted to show how the pedestrian volume is affected the duration of one hour during peak period. Figure 4.2 is a linear graph that shows how the pedestrian volume changes with time with one hour peak period.

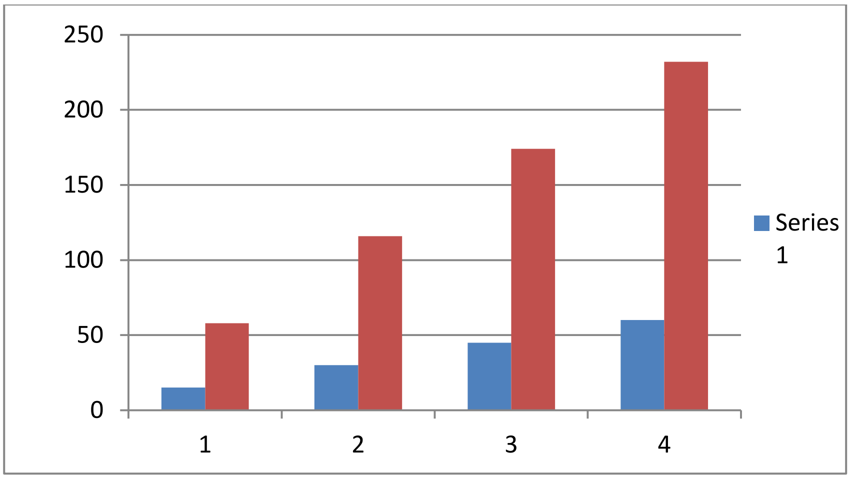

Figure .1 A histogram of pedestrian volume versus time duration

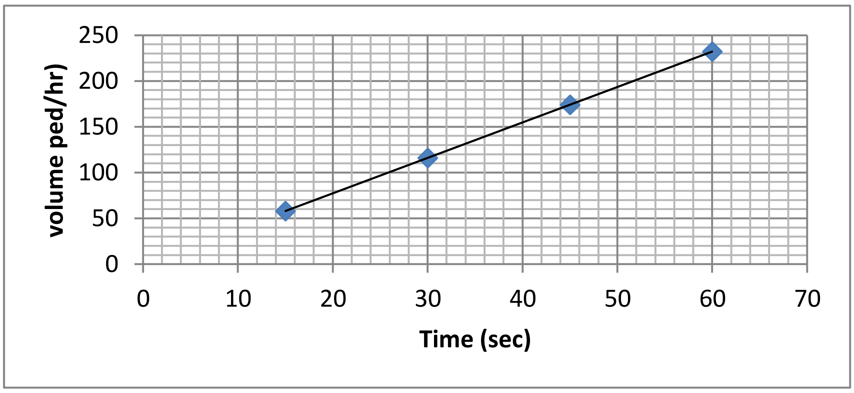

Figure .2 A linear graph of pedestrian volume versus time duration

Designing For Pedestrian Path

This Project is focused on the design of pedestrian path. This can be seen from the volume counts shown above. The figure 4.3 shows the plan of the Taiwo Road that has been designed with sidewalk of 2.0m on already designed double lane carriageway, shoulder and median.

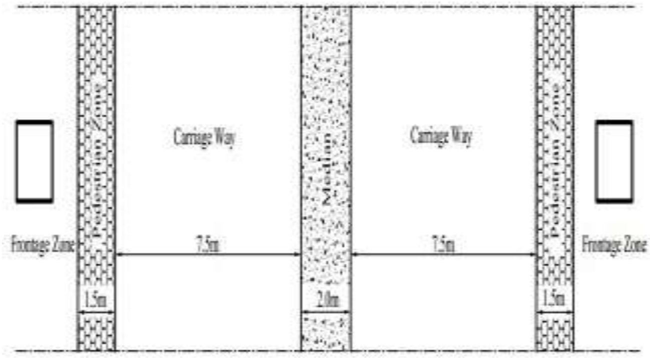

Figure 3: A Plan of the Taiwo Road

Figure 4.4 shows the cross section of the dualised Taiwo Road. The slope of the sidewalk is 5.5% while that of the carriageway is 2.5%.

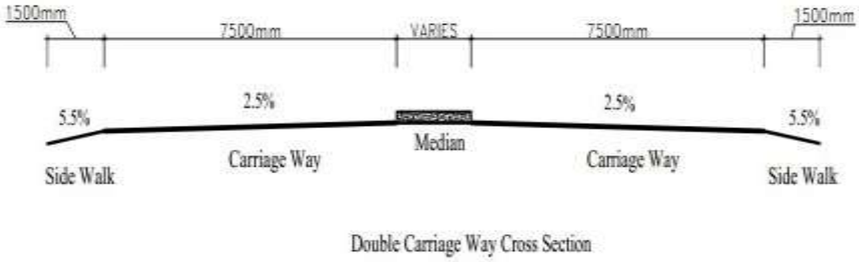

Figure 4: Proposed Cross section of the dualised Taiwo Road

Pedestrian Facilities

This figure 4.5 shows the designs of all the facilities that has been carried out as can be seen under design of side walk and design for sign and signal.

Figure 5: Description of all the facilities of the Taiwo Road.

Design of Sidewalk

Side walk width is 2.0m made of Bitumen macadam that will last for 40years. The shoulder is taken as the sidewalk because there is little or no space at all that will accommodate the sidewalk. Shops, houses and other buildings have taken over the space. The pedestrian sidewalk sis marked out using white line of 0.16m thickness. Surface should be firm, stable, slip resistance and prohibit openings. It has a cross slope of 2%.

Design of Crosswalk

The crosswalk Zebra crossing should be perpendicular to roadway and the parallel line should be 0.2-0.6 m in width and min. length 1.8 m (standard 3m). In this research work, vehicle priority (pedestrians give way to oncoming vehicles) crossing type is adopted because the Road has been designed as such. The width of painted lines on zebra crossings range between 3 m and 6 m; but 3.0 m is the design width for the work. The painted lines are to be white, 0.6 m wide, with 0.6 m spacing between the lines.

The positions of the zebra crossing are selected because of the high population of pedestrians at such locations at peak hours. Pedestrians' mobility is delayed and safety is reduced as some pedestrians are not patient enough for vehicles to have their right of way. The locations of the crosswalk facility (zebra crossing) along the Taiwo road are at: 3800m (close to the Hospital roundabout), 3200m (close to Adebayo clinic and maternity)2150m (close to the stadium), and 650m (between the Catholic Church and the ECWA Church) from Taiwo sale (Origin of Taiwo road).

Non Conforming Design

Zebra and Wombat crossings are used in shopping centres where non-conforming signing and pavement markings are common. However, they provide improved safety for pedestrians in this busy but slow vehicle environment. This design is to cater for these sections of the road.

Wombat crossing Design

The recommended platform height is 100 mm, except for bus routes where a maximum platform height of 75 mm is to be used. The approach ramp for motorists is a minimum of 1.2 m, up to 1.5 m on bus routes, and a maximum 1:20 grade on cycle route with the kerb crossing ramps (min. 2.4 m crossing gap). A 0.3 m vehicle stop line is to be installed, 6m back from the crosswalk lines For crossings without kerb protrusions, parking must be restricted for a minimum of 20 m in advance of the vehicle stop line, and 10 m on the departure side of the crosswalk lines to achieve minimum sight distances.

Platform surface material must provide adequate contrast with the white zebra crossing markings; for this reason brick paving is not suitable, along with maintenance issues as paint does not adhere well to brick (black or colored asphalt is preferred).

Children's Crossings Design

Children's crossings can only be installed on roads with: No more than one lane of traffic in each direction; except where the crossing is supervised by trained adult wardens. Adequate sight distance for vehicles and pedestrians and Kerb extensions and / or refuges can be used to improve visibility and stagger the crossing into two movements.

Pedestrian guideline markings are to be installed, 3.5 m apart aligned

Signalized Intersections Design

At a width of 3 m (absolute minimum width of 2 m), and up to 10 m where there is a large pedestrian demand. With at least 0.8 m separation from the vehicle stop line Vehicles turning at traffic signals are legally required to give way to pedestrians crossing the section of carriageway the vehicle is entering.

To provide extra protection for crossing pedestrians, turning vehicles can be delayed for part or all of the pedestrian crossing time. Pedestrian crosswalk markings provided at right angles (parallel crossings) are preferred as this: Minimizes the crossing distance and crossing phase time and Assists with orientation for vision-impaired pedestrians.

Design of Island

The Islands are located centrally in the road and enable pedestrians to cross one direction of traffic at a time. This is the simplest form of pedestrian refuge island which is an isolated concrete island. This is useful because there is a concentration of pedestrians and it is difficult to cross the full width of the road in one stage. The spacing of the islands is at 200m to 300m apart which provides an acceptable separation for pedestrians and avoids a wide

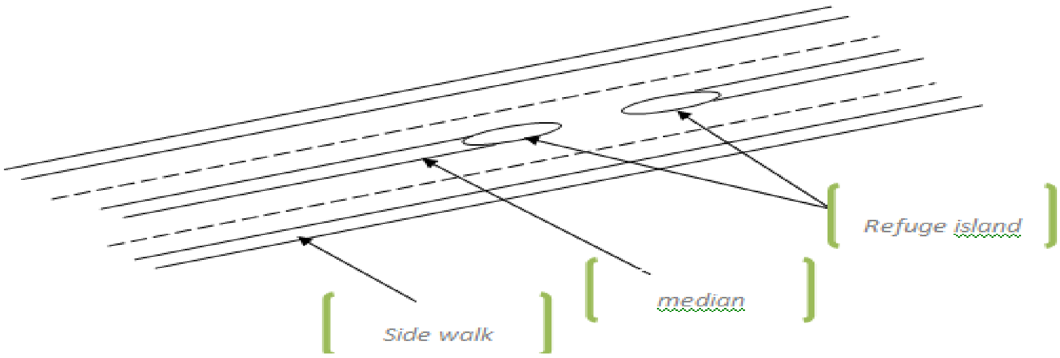

Figure 6: Descriptions of Sidewalk, Median and Refuge Island

The figure 4.2 shows the designs of the sidewalk, Median and the Refuge Island which discussed before. The sidewalk is 1.5metred, a raised Median of 2m width and a Refuge Island is 0.15m with Kerb Ramp

Design of Bus-Shelter

A continuous path with a desired width of 1.2m should be maintained between the bus shelter and the sidewalk white line. Rubbish bin should be located on the approach side of the shelter to maintain a continuous path. Warning signs/symbols are to be placed before the rubbish bin if they are located the Pedestrian path of the travel. Directional signs are to be used to lead to warning sign which locate the position of the front door of the bus/car (in front of the bus stop sign). The bus shelter should have lean rail, overhang and seating area.

The area where the two bus shelter are to be located are the 3800m (close to the Hospital round about), and 650m (between the Catholic Church and the ECWA Church) from Taiwo sale (Original of Taiwo road

Design for signs and signals

Direction signs are required to be placed at the changes in direction located at the traffic warden station. The height of the Pedestrian crossing sign is 1.6m and the directional sign at the intersection is 2m. If a sign has to be placed above a pathway then it should be cantilevered above a height of 2.5m for visibility. For legibility, the use of both plain English and symbols is encouraged and will greatly enhance access to the information for those with cognitive disability.

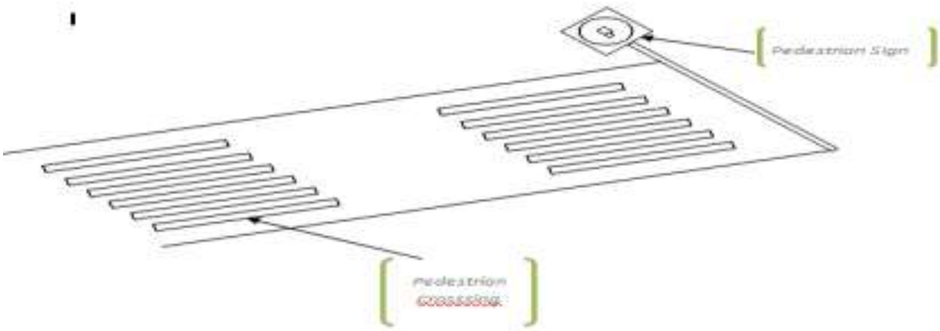

Figure 7: Descriptions of the Pedestrian Crossing and Pedestrian Sign

The figure 4.3 shows the design of the Pedestrian Crossing (Zebra Crossing) 0.6m spacing between the white and black stripes and 0.5m thickness. The Pedestrian Sign is 0.5m high above the ground.

Pedestrian signals

Pedestrian signals are designed basically considering minimum time gap required for crossing the Pedestrians. This minimum time gap can be calculated by using following gap equation.

$$Gs = \frac{W}{S_{ped}} + tc(N-1) + ts$$

Where, Gs=min time gap in sec, W= width of crossing section, ts= startup time, tc =consecutive time between two pedestrian, N=no of rows, and S_{ped}=pedestrian speed. (Tom V., 2014)

CONCLUSION

The following conclusions are drawn from the study

I. Taiwo road has no pedestrian facilities such as Sidewalk, Crosswalk, refuge Island Bus shelter and traffic Signs hence the need for the design of such as done in this research work.

II. The road is highly commercial and congested due to the fact that the average pedestrian volume is 538 per hour. To enhance safety and mobility, it is important to design these facilities.

III. The pedestrian facilities for Taiwo road were designed. The Sidewalk design width is 2.0m while the distance between the Crosswalk markings is 0.6m and the thickness of the Zebra crossing line is 0.6m at 3800m, 3200m 2150m and 200m from the origin of the road with 3m width, the Island height is 0.15m, the height of the signs above the ground is 2.0m and the Bus shelters are located at 3800 and 650m from the origin.

RECOMMENDATION

When pedestrian facilities are designed, the high dependency on fuel would be reduced, the carbon dioxide released from our vehicle and automobiles would have reduced its effect on the ozone layer thereby increasing the health of Nigerians. When these NMT facilities are increased across the nation, walking will be encouraged and enhanced.

In line with the above, the following are recommended:

1. The sustainability potential of pedestrian facility cannot be over emphasized and hence, should no longer be ignored in current transportation planning practices.
2. Consideration of the pedestrian facility when formulating, implementing or refining policies is recommended to maximize comfort and safety.

3. Furthermore, dense and congested routes, such as Taiwo road, can be pro
4. vided with pedestrian facilities.
5. The design developed in this research has shown how certain factors affects walking. It is strongly recommended for use for transportation design, even employed by similar cities facing this challenge.
6. The on-going efforts of the Federal Ministry of Transport to have a formidable national urban Transportation Policy should be re-focused to include walking as prominent modes of road transportation.
7. Further research can also be carried out on the sustainability potential of walking which is a non-motorized transportation mode. It is hoped that it can reduce the over dependence on motorized travel and attendant transportation probability

REFERENCES

AASHTO. (1993). "AASHTO Guide for the Design of Pavement Structures". American Association of State And Highway Transportation Officials.

Accident Compensation Corporation and Land Transport Safety Authority. 2000. Down with speed: "A review of the literature, and the impact of speed on New Zealanders". http://www.acc.co.nz/DIS_EXT_CSMP/groups/external_ip/documents/internet/wcm000021.pdf.

"Access Management Manual, Transportation Research Board", 2003.

Adebisi, 0. (1985). "Transport in Northern Nigeria." Chapter 3 in J.D.G.F. Howe et al. Rural Transport in Developing Countries. London: Intermediate Technology Publications.

Alan Baxter and Associates and EDAW. (2002). "Paving the way: How we achieve clean, safe and attractive streets". London: Commission for Architecture and the Built Environment.

Alexander, C. (1977). "A pattern language, towns-buildings-construction". New York: Oxford University Press.

Allan, A. (2001). "Walking as a local transport modal choice in Adelaide". Australia: Walking the 21st Century, 20 to 22February 2001: 122–134.

Architectural and Transportation Compliance Board. (1999). "Accessible rights of way: A design guide". United States: Architectural and Transportation Compliance Board.

Architectural and Transportation Compliance Board. (2002). "ADA Accessibility guidelines for buildings and facilities (ADAAG)".United States: Architectural and Transportation Compliance Board.

"A Policy on the Geometric Design of Highways and Streets", American Association of Highway and Transportation Officials, (2001).

Austroads. (1995). "Guide to traffic engineering practice": Part 13: Pedestrians. Australia/New Zealand: Austroads.

Austroads. (1999). "Guide to traffic engineering practice": Part 14: Bicycles. Australia/New Zealand: Austroads.

Austroads. (2004). "Guide to traffic engineering practice": Part 10: Local area traffic management.

Australian Local Government Association, National Heart Foundation of Australia and Planning Institute of Australia, (2009) Healthy Spaces and Places: "A national guide to designing places for healthy living", Planning Institute of Australia, Canberra, ACT.

Axelson, P. W., D. A. Chesney, D. V. Galvan, J. B. Kirschbaum, P. E. Longmuir, C. Lyons, and K. M. Wong. (1999). "Designing sidewalks and trails for access. Part 1 of 2: Review of existing guidelines and practices". United States: Department of Transportation.

Bass, Wade and Wig more. (2004). "School journey safety – A comparative study of engineering devices". Wellington. Land Transport New Zealand.

Beasley, S. (2002). "Why our children are not as safe as we think they are". Journal of the New Zealand Medical Association115, no. 1160.

Barwell, I.J. and I. Legget. (1986). "Study on Promotion of Rural Transport in Tanga Region". Consultancy Report by I.T. Transport Ltd. for GTZ on behalf of TIRDEP.

Berrigan, D, Troiano, Rp, Mcneel, T, Disogra, C, and Ballard-Barbash, R (2006). "Active transportation increases adherence to activity recommendations", American Journal of Preventive Medicine 31(3):210-216.

Boivin, R. and J-F Pronovost (eds). 1992. The Bicycle: Global Perspectives Conference

Bristol City Council. (2004). Bristol legible city. www.bristollegiblecity.info.

British Heart Foundation. (2004). Marketing and promoting 'Walking for Health' schemes: Advice note 3 from publications page of http://www.whi.org.uk.

Brown Andrew and Brown Alan. Information sheets – "Trip hazards, human gait and misstep hazards". http://www.cnf.com.au/forensic.shtml.

Burden, D. (2004). "How can I find and help build a walk able community"? www.walkable.org/article3.htm.

BURKE, M, and BROWN, AL (2007). "How much household travel is 'active transport"? Unpublished manuscript."Bicycle safety guide and counter measure selection system", http://www.guide.saferouteinfor.org

"Curbs ramps and pedestrian crossing", (2012). http://www.ada.gov/pcatoolkit/chap6toolkit.htm

Cairns, S. (2000). "Rethinking transport and the economy". Town and country planning 69, no. 1(January): 6–7 United

Kingdom. Christchurch City Council. Living streets: Creating a better balance. Christchurch: Christchurch City Council. Also http://archived.ccc.govt.nz/programmes/livingstreets/ (October 2016)

City of Kansas City Council. (2003). Kansas City walk ability plan. City of Kansas City Council.

City of Portland Office of Transportation. (1998). "Portland pedestrian design guide". City of Portland. http://www.portlandonline.com/transportation/index.cfm?c=dejff.

City of York Council. (2001). "Local transport plan". City of York Council

Daaman, W. and S. P. Hoogendoorn. (2003). "Experimental research of pedestrian walking behavior". www.ltrc.lsu.edu/TRB_82/TRB2003-001113.pdf.

Department for the Environment, Transport and the Regions. (2000). "Encouraging walking: Advice to local authorities".

Department for Transport. (2003). "Walking: The way ahead". United Kingdom: Department for Transport.www.dft.gov.uk/consultations/archive/2003/omf/walkingthewayahead.

Department for Transport. (1993). Traffic advisory leaflet 09/93: "Cycling in pedestrian areas". United Kingdom: Department for Transport. http://www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_504728.hcsp

Department for Transport. (1994). Traffic advisory leaflet 01/94: "Village speed control work group" – A summary.