# Assessment of the levels of service for roads in the Central Business District (CBD) of Akure, Nigeria

## Evaluarea nivelurilor serviciului pentru drumuri din districtul central de afaceri (CBD) Akure, Nigeria

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**Abstract.** *Traffic metering parameters in the CBD of Akure such as traffic composition and volume-capacity ratio were collected and evaluated to determine the levels of service of the selected major roads namely Oba Adesida road (directions A and B): direction A from Cathedral junction to 'A' Division and Direction B from 'A' Division to Cathedral junction and Arakale road (directions C and D): direction C from Isikan roundabout to NEPA roundabout and direction D from NEPA roundabout to Isikan Roundabout. The traffic composition analysis revealed the passenger car/taxi as the predominant mode while poor parking system, trading activities along the carriageway, bad roads, construction activities were identified as factors affecting the levels of service.*
***Key words:*** *Traffic metering; Levels of Service; traffic composition; volume-capacity ratio, junction.*

### 1. Introduction

Efficient transport systems provide economic, social opportunities and benefits that result in positive multiplier effects such as accessibility to markets, employment and safety. However, inefficient transport systems have economic costs such as reduced or missed opportunity, lower quality of life and adverse effects on people's lives [1].

Traffic congestion means there are more vehicles trying to use a given road facility than it can handle- without exceeding acceptable levels of delay or inconvenience. In major cities, this occurs mostly during certain times of the day called peak periods or rush hours. There are two clear parameters within a single equation that causes congestion, which is the balance between the demand and the supply of road space [2].

Level of Service (LOS) can be defined as a designated term used to qualitatively describe the operating conditions of a roadway based on parameters such as volume/capacity ratio, speed, travel time, maneuverability, delay and safety [3]. It

designates six levels of service for each type of facility, from A to F, with Los "A" representing the best conditions and LOS "F" the worst.

The operating conditions for these six levels of service identified are as follows [4]:

- Level of service "A": Free flow with low volume and high speed, traffic density is low, with speed controlled by drivers desired speed limits and physical roadway conditions individual users are virtually unaffected by others in the traffic stream : volume-capacity ratios (v/c) vary from 0.00 to 0.60.
- Level of service "B": represents the range of stable flow but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speed is relatively unaffected but there is a slight decline in the freedom to maneuver within the traffic stream from LOS A: v/c vary from 0.61 to 0.70
- Level of service "C" represents the range of stable flow but the selection of speed is affected by the presence of others. Maneuvering within the traffic stream requires substantial vigilance on the part of the user, v/c vary from 0.71 to 0.80.this is the target LOS for some urban and most rural highways.
- Level of service "D": Approaches flow, with tolerable operation speed being maintained through considerably affected changes in operating conditions. Fluctuations in volume and temporary restrictions to flow may cause substantial drops in operation speeds. Drivers have little freedom to maneuver; comfort and convenience are low, but conditions can be tolerated for short periods of time. Minor incidents are expected to create delays, v/c vary from 0.81 to 0.90
- Level of service "E": unstable flow, operating at capacity, cannot be described by speed alone but represent operations at even lower operating speeds than in level D with volumes at or near the capacity of highway. At capacity, speeds are typical but not always in the neighborhood of 50km/h. Flow is unstable and there may be stoppage of momentary duration. Drivers' level of comfort becomes poor. Freedom to maneuver within the traffic stream is extremely difficult, v/c vary from 0.91 to 1.00
- Level of service "F". Forced flow operations at low speeds, where volumes are above capacity. Conditions result from queues of vehicles backing up from a restriction downstream. Speeds are reduced substantially and stoppage may occur for long or short period of time, because of downstream congestion.travel time cannot be predicted, with generally more demand than capacity. A road in a constant traffic jam is at this LOS. In extreme conditions, both speed and volume can drop to zero, v/c is greater than 1.00

There is a need for Passenger Car Equivalence (PCE) to be defined by the traffic engineer both in the design of traffic facilities and also in the management of vehicles operations [5]. Each vehicular type such as tricycles, car, buses, truck/lorry in the traffic stream cannot be considered as equivalent to each other as there is significant difference in the vehicular and flow characteristics of each vehicle class. Therefore a Passenger Car Equivalent is majorly the impact that a mode of transport has on traffic variables (such as headway, speed, density) compared to a single car [6]. Table 1 shows the Passenger Car Equivalents used to convert the traffic volume to passenger car unit per hour (PCU/h).

The traffic volume in Akure Central Business District was analyzed so as to reveal the cause of parking problems [7]. Increased volume of traffic ribbon development/street trading and improper structural layout/land use pattern within the Central Business District (CBD) were factors responsible for these problems. Oyemekun and Arakale roads are the major arterials in Akure metropolis. The aim of the research is to determine the nature of traffic in terms of volume/capacity ratio as well as determine the future level of service of these routes (Direction A and B). The result of this research will help transportation agencies and government in proffering adequate measures for reduction of traffic congestion on major roads in Akure and similar capital cities in Nigeria.

*Table 1*

**Passenger Car Equivalents**

| Vehicle Type | Equivalent Passenger Car Units |
|---|---|
| Pedal Cycle, Tricycles and Motor Cycles | 0.5 |
| Motor-car, Station Wagon, Taxi, Kit-Car | 1 |
| Pick-up, Jeep, Land Rover, Light Delivery Van, Minibus<br>Trailer attached to above | 2 |
| 2-Axle Truck Class, Lorry including Timber<br>Lorry, Truck, Mammy Wagon, Petrol Tanker<br>Trailer attached to above | 2<br>3 |
| 3 to 5 Axle Combination, Tractor Trailer including Low Loader, Petrol Tanker, Bus (Excluding Municipal) | 3 |
| Municipal Bus, More than 5 Axle Combination | 4 |

**Source:** FMW&H Nigeria Highway Manual (2013)

## 2. Materials and Methods

Akure is the administrative capital of Ondo State. Akure became the state capital of Ondo State in 1976. The town is located on latitude $70^0$15′North of the Equator and Longitude $50^0$05′East of the Greenwich Meridian. The climate is hot and humid with two distinct seasons, the rainy and dry seasons. The rainy season lasts for seven months (April – October) and the dry season for five months (November–March). The rainfall is about 1524 mm per year and the atmospheric temperature ranges between 28˚C and 31˚C with a relative humidity of 80 percent [3]. The most noticeable of the physical expansion of the city is its population growth and urban landmass. The population rose from 123,000 in 1985 to 239,124 in 1991. The national population projection for the year 1996 and 2000 put the city population at 269,207 and 298,712 respectively. However, a sharp increase was recorded in the 2006 census, which put Akure South at 353,211 [8]. The projection for the year 2020 put the city population at 571,740 with a growth rate of about 3.5 percent per annum [9]. Figures 1 shows Akure Street Map highlighting the Central Business District.


Fig. 1. Akure Street Map Highlighting the Central Business District. Source: Google Map, (2019)

The research covers two selected major roads:

a. Oba Adesida road: Direction A which is from Catheral Junction to A Division and Direction B which is from A division to Catheral junction.

b. Arakale road: Direction C which is from Isinkan Roundabout to NEPA roundabout and Direction D which is from NEPA roundabout to Isinkan Rounabout as shown in Table 2.

The following are some of the materials used in carrying out this research: Stop watch, Traffic Jackets, Cine Camera and recording sheets. A reconnaissance visit was made to the study area for on-the-spot evaluation of some selected traffic congestion points. Traffic data collected were on the field, using camera to capture three dimensional situations of traffic jam and traffic counts.

*Table 2*

**Selected routes segmentation**

| Routes 1 | Direction A | Direction B |
|---|---|---|
| Oba Adesida | Cathedral Junction to A" Division | "A" Division to Cathedral Junction |
| Routes 2 | Direction C | Direction D |
| Arakale | Isinkan Roundabout to NEPA Roundabout | NEPA Roundabout to Isinkan Roundabout |

These two routes were selected as they were the major feeders of other arterial routes critical to traffic flow in the study area. Traffic parameters were metered using cine cameras which were placed on the pedestrian bridge in front of the Akure central Mosque on Oba – Adesida Road (OAR) and Globec Plaza Opposite Adedeji Park on Arakale Road (ARR). These two points served as vantage points from the road section to take inventory of the morning, afternoon and evening peak periods. These peak

periods were established to be between 7:00-9:00am, 12:00-2:00pm and 4:00-6:00pm for morning, afternoon and evening respectively on weekdays (Monday to Friday); 9:00-11:00am, 12:00-2:00pm and 4:00-6:00pm on Saturdays; 7:30-9:30am, 12:00-2:00pm and 4:00-6:00pm on Sundays [10].

Data on traffic composition and volume were collected by recording the types of vehicles namely motorcycles, cars, vans or buses and trucks captured by the video footage in a sheet [11]. These were arranged on the sheet in ascending order of their vehicular capacities. The sheet was marked as vehicles passed the reference point on the road as shown in the video footage. The traffic volume was converted to passenger car unit per hour (pcu/h) by multiplying each vehicle with their respective passenger car unit equivalents in order to get the approximate number of vehicles that ply the selected roads during the chosen peak periods in terms of passenger car [12].

The capacity for two – lane road is 2800pcu/h, therefore the level of service was determined by the analysis of volume – capacity ratio (v/c) traffic projection for 10 years.

$$Q_n = Q_0(1+r)^n \quad (1)$$

where:

$Q_n$ - Projected traffic volume (pcu/h)

r -Traffic growth rate

n - Number of years for which projection is made

$Q_0$ - Observed maximum traffic volume

Assuming a traffic growth rate of 3% [13] for developing countries, a projection period not greater than 20 years is recommended [14].

## 3. Results and Discussion

Tables 3 and 4 show the traffic composition of vehicles that ply Oba Adesida and Arakale roads for the week. The tables revealed that the most predominant mode of transport along the two roads are passenger cars/taxi which constitute approximately 84.57% and 64.39% respectively, followed by motorcycles which constitute 13.26% and 32.48 respectively while tricycles, mini buses /vans, buses and trucks/lorries constitute the rest of the percentages

*Table 3*

**Traffic Composition for Oba - Adesida Road during Peak Periods for the week**

| Vehicle Class | Morning Peak | Afternoon Peak | Evening Peak | Total | Percentage (%) |
|---|---|---|---|---|---|
| Bicycle | 51 | 11 | 32 | 94 | 0.07 |
| Motorcycle | 4,502 | 5,716 | 6,942 | 17,160 | 13.26 |
| Tricycle | 33 | 37 | 44 | 114 | 0.09 |
| Passenger Car | 35,132 | 33,172 | 41,112 | 109,416 | 84.57 |
| Mini van | 42 | 56 | 53 | 151 | 0.12 |
| Buses | 515 | 498 | 646 | 1659 | 1.28 |
| Trucks/Lorries | 151 | 342 | 294 | 787 | 0.61 |
| | 40,426 | 39,832 | 49,123 | 129,381 | 100 |

*Table 4*

**Traffic Composition for Arakale Road during Peak Periods for the week**

| Vehicle Class | Morning peak | Afternoon peak | Evening peak | Total | Percentage (%) |
|---|---|---|---|---|---|
| Bicycle | 34 | 13 | 43 | 90 | 0.08 |
| Motorcycle | 11,549 | 11,385 | 12,103 | 35,037 | 32.48 |
| Tricycle | 61 | 85 | 106 | 252 | 0.23 |
| Passenger Car | 23,042 | 20,567 | 25,859 | 69,468 | 64.39 |
| Mini van | 47 | 65 | 77 | 189 | 0.18 |
| Buses | 472 | 679 | 684 | 1,835 | 1.70 |
| Trucks/Lorries | 215 | 406 | 389 | 1,010 | 0.94 |
| | 35,420 | 33,200 | 39,261 | 107,881 | 100 |

Traffic Flow

Tables 5 and 6 present the maximum hourly volume (MHV) for Oba–Adesida and Arakale roads for the week. The MHV recorded for Oba –Adesida road for both directions is 2369.5 pcu/h and 1860pcu/h while that of Arakale road is 1987.5 pcu/h and 1876.5pcu/h. The implications of these values as obtained for the maximum volume on both routes depict the high level of commercial activities going on in the CBD. As more people commute towards and along these routes for their daily activities, this often times result in traffic hold-ups and jams. Such result is expected around the CBD because of the commercial activities constantly occurring there [15].

*Table 5*

**Maximum and minimum flow and passenger car unit for Oba Adesida road**

| | DIRECTION A | | | | DIRECTION B | | | |
|---|---|---|---|---|---|---|---|---|
| Week | Veh/h | | PCU/h | | Veh/h | | PCU/h | |
| | Max | Min | Max | Min | Max | Min | Max | Min |
| Monday | 2171 | 1626 | 1815.5 | 1369 | 1992 | 1440 | 1613.5 | 1272 |
| Tuesday | 2257 | 1550 | 1866 | 1291 | 1932 | 1539 | 1631 | 1314.50 |
| Wednesday | 2856 | 1835 | 2369.5 | 1498.5 | 1919 | 1585 | 1680 | 1421 |
| Thursday | 2261 | 1528 | 1927.5 | 1427 | 1915 | 1457 | 1703 | 1260.50 |
| Friday | 2555 | 1867 | 2122.5 | 1459 | 1936 | 1702 | 1502.5 | 1355 |
| Saturday | 2837 | 2074 | 2259.5 | 1683 | 2110 | 1719 | 1720.50 | 1401.50 |
| Sunday | 2191 | 2025 | 1831 | 1604.50 | 2272 | 1828 | 1860 | 1505 |

*Table 6*

**Maximum and minimum flow and passenger car unit for Arakale road**

| | DIRECTION C | | | | DIRECTION D | | | |
|---|---|---|---|---|---|---|---|---|
| Week | Veh/h | | PCU/h | | Veh/h | | PCU/h | |
| | Max | Min | Max | Min | Max | Min | Max | Min |
| Monday | 2298 | 1592 | 1805 | 1281.5 | 1968 | 1488 | 1557 | 1215.5 |
| Tuesday | 2317 | 1772 | 1776 | 1413.5 | 2008 | 1702 | 1684.5 | 1352 |
| Wednesday | 2515 | 1483 | 1987.5 | 1282 | 2274 | 1833 | 1796.5 | 1463.5 |
| Thursday | 2101 | 1699 | 1609.5 | 1265 | 2465 | 1807 | 1876.5 | 1459 |
| Friday | 2089 | 1895 | 1644 | 1423.5 | 2051 | 1752 | 1557.5 | 1343.5 |
| Saturday | 2167 | 1709 | 1697.5 | 1412.5 | 2060 | 1856 | 1630 | 1482.5 |
| Sunday | 1912 | 1490 | 1474.5 | 1170.5 | 2020 | 1789 | 1569.5 | 1482.5 |

## Volume- Capacity Ratio

Table 7 presents the results for the future level of service of both Oba – Adesida and Arakale roads.

*Table 7*

**Analysis of Volume to Capacity Ratio and Levels of Service for peak period on both routes.**

| Routes | MHV week (vph) | Volume to Capacity Ratio (V/C) | Level of Service (LOS) | Remark | Maximum Projected Traffic (10yrs) | Future Volume to Capacity Ratio (V/C) | Level of Service (LOS) | Remark |
|---|---|---|---|---|---|---|---|---|
| Oyemekun to Oba-Adesida | 2856 | 1.09 | F | Unfavourable | 3848 | 1.47 | F | Unfavourable |
| Oba-Adesida to Oyemekun | 2272 | 0.87 | D | Unfavourable | 3053 | 1.17 | F | Unfavourable |
| Isikan to Arakale | 2515 | 0.97 | E | Unfavourable | 3580 | 1.37 | F | Unfavourable |
| Arakale to Isikan | 2465 | 0.95 | E | Unfavourable | 3313 | 1.27 | F | Unfavourable |

The implication and the causes of level of service on each direction has been highlighted in Table 7. Furthermore, the future Level of Service for all the routes (directions) is “F” which indicates severe congestion by the year 2029. However, the highest volume was recorded for Oba Adesida direction A which as a result of the presence of commercial activities around the surrounding areas such as car street, Akure town hall, post office, Erekesan market and Olukayode building with no parking system along the stretch unlike direction B. Table 8 shows the summary results of causes, effects and measures taken for the levels of service obtained along both directions.

*Table 8*

**Summary result showing effects, causes and measures of level of service along the routes**

| Route | LOS | PAG standard | Causes | Effect of the level of service | Measures |
|---|---|---|---|---|---|
| Cathedral Junction to A" Division {Oba Adesida direction A) | F | Heavy congestion | Increased volume of traffic which is predominated by passenger car/taxi, poor parking system, increase socio economic activities | Unstable flow, drivers level of comfort is poor | Restriction of illegal activities. Increase the capacity. Replacement of existing transport modes |
| "A" Division to Cathedral Junction{Oba Adesida direction B) | D | Heavy congestion | Approaches unstable, high density, poor levels of comfort and convenience. | Unstable flow, drivers level of comfort is poor | Restriction of illegal activities. Increase the capacity. Replacement of existing transport modes |
| Isinkan Roundabout to NEPA Roundabout(Arakale direction C) | E | Heavy congestion | Long vehicles park to off load, poor maintenance of alternative roads. Poor parking | Unstable flow, operating at capacity | Maintenance of alternative roads. Making frequent use the available parking space |
| NEPA Roundabout to Isinkan Roundabout(Arakale direction D) | E | Heavy congestion | Long vehicles park to off load, poor maintenance of alternative roads .poor parking\ | Unstable flow, operating at capacity | Maintenance of alternative roads. Marking frequent use the available parking space |

## 4. Conclusions

The level of traffic and corresponding levels of service on Oba Adesida road, direction A and B and Arakale road, directions C and D were determined through metering parameters such as traffic composition and volume/capacity ratio. The corresponding present level of service is F, D, E, and E respectively. The effect is that for all the routes, unstable flow, high density and poor comfort and convenience subsist. Assuming a projection of 10 years for developing countries, the levels of service for all the routes was obtained as "F" which would imply severe congestion by 2029. Therefore to sustain, develop and maintain transportation infrastructure in Akure and Nigeria at large, design measures such as expansion of roads leading to the CBD,

abolition of illegal parking/trading, and provision of adequate parking facilities should be implemented.

**Conflicts of Interest:** The authors declare no conflicts of interest.

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