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DETERMINATION OF TRAFFIC CHARACTERISTICS FOR AN URBAN ROAD UNDER MIXED TRAFFIC CONDITIONS

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ABSTRACT

This work seeks to establish the traffic characteristics of Oba Adesida road in Akure city. Traffic count for the study road was conducted using video-graphic technology and manual techniques for seven days between 7:00am and 7:00pm. The passenger car unit (PCU) factor was employed to determine the volume of vehicles across the study area. The peak hour, peak hour volume and peak hour factor for the road were determined from the 15 mins ranges of vehicular movement. The results indicate a peak hour volume of 4111pcu between 7:30am and 8:30am and 3894pcu between 4:30pm and 5:30pm. Also, the peak hour factor of 0.9797 was obtained from the traffic data. The road is highly congested and it is recommended that trading and hawking at roadway corridors, shoulders and walkways should be discouraged.

1. Introduction

Cities in the developing countries are well branded through the characteristics of the continual development of transportation infrastructure, level of vehicle ownership, and service expansion to meet the present and future demand of economic situations of people [1], [6]. It can be said that the main challenges of these cities are frequently connected with congestion of traffic, poor movement of vehicles, environmental issues, and the challenges of safety. [2], [3], [6].

Congestion usually emanates with the increasing traffic demand which results in total utilization of road capacity. It is worthy of note that road capacity of any road infrastructure can vary indiscriminately based on the category of the road infrastructure, the purpose being served, the current condition of the road, and the natural traffic dynamics and so on [1], [6], [14].

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The Akure city's developmental pattern follows a linear progression, particularly along its main arteries like Oba Adesida road [12]. Within this urban area, uncontrolled intersections are prevalent, typically overseen by government traffic officers. This might be attributed to the political status of the city. The city was initially a provincial headquarters and later a state capital thus serving as the seat of both the local and State Governments since 1976 [12]. This political status of the city made the inflow of so many people to the city for employment and other related activities. Because of this, it is generally expected that the environmental situation would be critical without adequate planning and monitoring [12]. Over the years, the city of Akure has witnessed a significant surge in the number of vehicles on its roads, primarily driven by escalating socioeconomic activities [11], [12]. The importance of determining traffic characteristics of this road will no doubt help the understanding of the traffic volume in operation in relation to congestions**,** thereby orchestrates the analysis of capacity and level of service of the road [3], [13], [14].

Several researchers have explored traffic congestion in the literature. These studies presented an understanding of the major challenges of arterial roads leading to congestion and their prospective solutions. [8] It explored the Estimation of highway capacity under environmental constraints versus conventional traffic flow criteria: A case study of Tehran. The study introduced the concept of environmental capacity, determining the maximum traffic volume permissible without compromising residents' quality of life. [9] It focused on the Diagnosis of road capacity and service level using the highway capacity manual in Santander, Colombia. The study concluded that the system operated at a level of service D and E. [17] carried out Synchronization of Signalized Intersections: A Case Study of Three Major Intersections on the 24th February Road, Kumasi, Ghana. The Chi square test and t-test analyses showed that headway had a strong correlation with saturation flow when compared with speed for both field at 5% significant level and simulated conditions. It was concluded that changes in phasing plan with geometric improvement would improve the selected signalized intersection’s level of service. [11] also carried out Traffic Regulation at Critical Intersections: A Case Study of Odole Intersection, Akure, Ondo State, Nigeria. They discovered through reconnaissance survey that traffic congestion on major roads consequent upon existing bottlenecks at intersections is a major problem in Akure Metropolis. Peak and off-peak traffic volume data were collected and analyzed. The result shows that the major contributors to traffic are Motorcycles (70.88%) and Passenger Cars (28.72%). Other modes of transportation settle for 0.4% of vehicles traversing the intersection. Consequently, traffic control by signalization was selected and designed to suit Odole intersection. [4] worked on Traffic Congestion Assessment of Akure Central Business District Using Geographic Information System (GIS). The research was able to identify the causes of traffic congestion, analyzing the traffic patterns, developing a data base of the traffic attributes and suggesting practical solutions for reducing traffic congestion with the aid of GIS. Considering the forecasts made by [5] predicting severe congestion on specific routes especially on Oba Adesida road by 2025, it becomes essential to conduct a research study in 2023 to determine traffic characteristics such as peak hour, peak hour volume and peak hour factor on the road. This would give valuable insights into the current state of the road, allowing for the justification or challenge of the earlier projections. However, the absence of a focused study on Oba Adesida Road in Akure with the determination of traffic characteristics remain a significant intellectual gap in the present body of knowledge.

1.1 The Study Road

One of the major and oldest roads in Akure city is Oba Adesida road which is the focus of this research work. Oba Adesida road links and traverses major land uses in the area such as banks, insurance and financial institutions, shopping mall, markets, eateries, and offices including government quarters among others. This road was the busiest route, when compare with other roads in the city [10]. This route is therefore prone to traffic congestion and bottleneck which can result to unnecessary transit waiting time [10]. Despite the escalating costs associated with fuel consumption, Oba Adesida road has not seen a reduction in vehicular

traffic. The traffic makeup in the metropolis is observed to be diverse, encompassing motorcycles, tricycles, taxis, buses, and trucks (trailers) but dominated by motorcycle, taxi and buses [11].

This road was considered, from Sacred Heart Cathedral Junction to Oba Osupa/Police A-division junction. The road is divided into two by median. Each section contains three lanes. The length of this road is 1.8km. It serves as a feeder road to other important routes in the city. Figures 1 and 2 show the pictures of the road during off peak and peak hours.

Figure 1: During off-peak hour

Figure 2: During Peak hour

One of the influencing factors to congestion is the road environment activities which may determine increase in traffic flow. This in turn can affect capacity of the road. Oba Adesida road has enormous commercial activities which were around this road on both directions. It was observed that a number of hawkers, vendors, and roadside traders, together with various stores and shops line up along the road, creating a suitable setting for traffic congestion. There were few poor traffic signals at some designated areas along this road and these few traffic signals were already defective and no longer in good operating condition. However, there was little control of traffic by government traffic wardens/officers. Their effort was not enough to eliminate traffic congestions at peak hour of the day on this road.

2.0 METHODOLOGY ADOPTED

The British standard method [2] was used to ascertain the actual peak periods and off peak periods of the traffic volume of Oba Adesida road. The traffic count was conducted between 7:00am and 7:00pm for seven days spanning from Monday to Sunday [2]. Video-graphic technology which allows several occurrences to be observed at the same time and manual techniques were employed [7]. The passenger car unit equivalent technique using the British standard method where PCU factors for each classes of vehicle such as 0.75, 1.00, 2.00, 3.00 and 4.00 for motorcycle/tricycle, car, busses, 2-Axle truck, 3-Axle truck, 4-Axle trucks and articulated vehicles [2], [18] respectively were used. Since the traffic composition characteristics of Oba Adesida road strictly involve mixed traffic conditions that consists of motorcycles, tricycles, taxis, buses, and trucks, the trucks were therefore simplified further into 2-axle, 3-axle, 4-axle and 5-axle trucks. Table 1 reveals the classifications of the vehicles according to their corresponding passenger car unit (PCU) factors. Determination of Peak Hour (PH) was done by reviewing the 15 mins ranges of vehicular movement with PCU values for both in-coming and outgoing vehicles. The operation was divided into morning and evening sections. The highest four consecutive 15 mins interval values were used to determine the peak hour for both

morning and evening sessions. Table 3 shows the analysis of the traffic variations for the two sessions. Furthermore, Peak Hour Volume (PHV) was determined through the calculation of the sum of the volumes of four 15minute consecutive intervals within the peak hour. From the main procedure of highway Capacity Manual (HCM) 2016, the stationary observer approach was used to find the peak hour factor (PHF) within the peak-hour.

Table 1: Vehicular Traffic Classifications PCU equivalent Factors

S/N	1	2	3	4	5	6	7
Vehicle Classifications	5-Axle Truck	4-Axle Truck	3-Axle Truck	2-Axle Truck	Bus	Car	Tricycle/ Motorcycle
PCU Factors	4.0	4.0	3.0	2.0	2.0	1.0	0.75

Source: [7] (2022).

Table 1 shows vehicular traffic classifications with passenger car unit (PCU) equivalent factors corresponding to each class of vehicles. While tricycle and motorcycle has 0.75pcu factor, 5-Axle truck has 4.0pcu. Car, and Bus shares PCU factors of 1.0 and 2.0pcu. Trucks with axles ranges from two to four settle with PCU factors between 2.0pcu and 4.0pcu [2].

3.0 RESULTS AND DISCUSSION

The following data were captured between Monday 25 th September and Sunday 1 st of October 2023. The summary of each day traffic capacity for the whole week was determined and recorded. Table 2 presents road traffic characteristics for these periods of seven days (Monday - Sunday) with both field values and passenger car unit equivalents (PCUE) from in-coming and out-going vehicles respectively.

Table 2: Summary of Traffic Characteristics Capacity for the Whole Week

	IN-COMING VEHICLES		**OUT-GOING VEHICLES**		
DAYS	**Field Values**	**Approx. PCUE Values**	**Field Values**	**Approx. PCUE Values**	**Average PCUE Values**
Monday	25050	22393	23053	20894	21644
Tuesday	25277	22633	23117	19945	21290
Wednesday	24237	21894	23076	20899	21397
Thursday	27090	25788	23539	22304	24047
Friday	24031	22124	23387	21390	21757
Saturday	17425	16065	16346	15289	15677
Sunday	15090	13908	14970	13818	13863

Source: Field Survey, 2023

It can be observed that Thursday traffic capacity characteristics have the highest traffic with average PCUE value of 24047pcu/day when compared with the rest of the days. Sunday has the least traffic values of 13863pcu/day. Incoming vehicles volume are more than outgoing vehicles throughout the days of the week. Incoming vehicles are more than outgoing vehicles throughout the days of the week. While the outgoing vehicles range between 13818pcu/day and 20894pcu/day; the incoming was between 13908pcu/day and 22393pcu/day. The study shows that the selected road is highly congested with traffic volume between 1080–2221 pcu/hr. and 13863 – 25788pcu/day with the consideration of both directions.

Table 3: 15 mins Interval Traffic Variations at Peak Hour with PCU Values

Morning Session				Evening Session			
TIME INTERVAL	**Total PCUE Values In-Coming**	**Total PCUE Values Out-Going**	**Grand Total**	**TIME INTERVAL**	**Total PCUE Values In-Coming**	**Total PCUE Values Out-Going**	**Grand Total**
7:00 – 7:15am	416	389	805	**4:00 – 4:15pm**	460	438	898
7:15am – 7:30am	471	435	906	**4:15 – 4:30pm**	484	439	923
7:30am – 7:45am	519	467	**986**	**4:30 – 4:45pm**	483	470	**953**
7:45am – 8:00am	551	484	**1035**	**4:45 -5:00pm**	511	460	**971**
8:00am – 8:15am	572	477	**1049**	**5:00 – 5:15pm**	513	463	**976**
8:15am – 8:30am	561	480	**1041**	**5:15 – 5:30pm**	521	473	**994**
8:30 – 8:45am	521	465	986	**5:30 – 5:45pm**	491	454	945
8:45 - 9:00am	512	462	974	**5:45 – 6:00pm**	502	463	965

Source: Field Survey, 2023

The peak hour (PH) was discovered to be between **7:30am and 8:30am, then 4:30pm and 5:30pm.** This period had the highest traffic volume throughout the days of the week. The peak hour volume (PHV) of 4111 pcu and 3894pcu were determined for morning and evening during peak hours. The average of the PHV was calculated to be 4003pcu. The Peak Hour Factor (PHF) was determined as well to be 0.9797. This period forms time interval for students going to school and civil servants resumes offices. Also some business men especially commercial workers find this period suitable to resume work for the day because this road was occupied by commercial hub of the city on both directions. The evening period was the period where people basically retire from work of the day especially business offices owners [4], [5], [11].
Figure 3 shows the traffic volume variation at peak hour for morning session. Each time interval consists of the traffic volume for incoming and outgoing vehicles. The blue colour represents incoming vehicles, red denotes outgoing vehicles and green colour shows the total traffic volume.

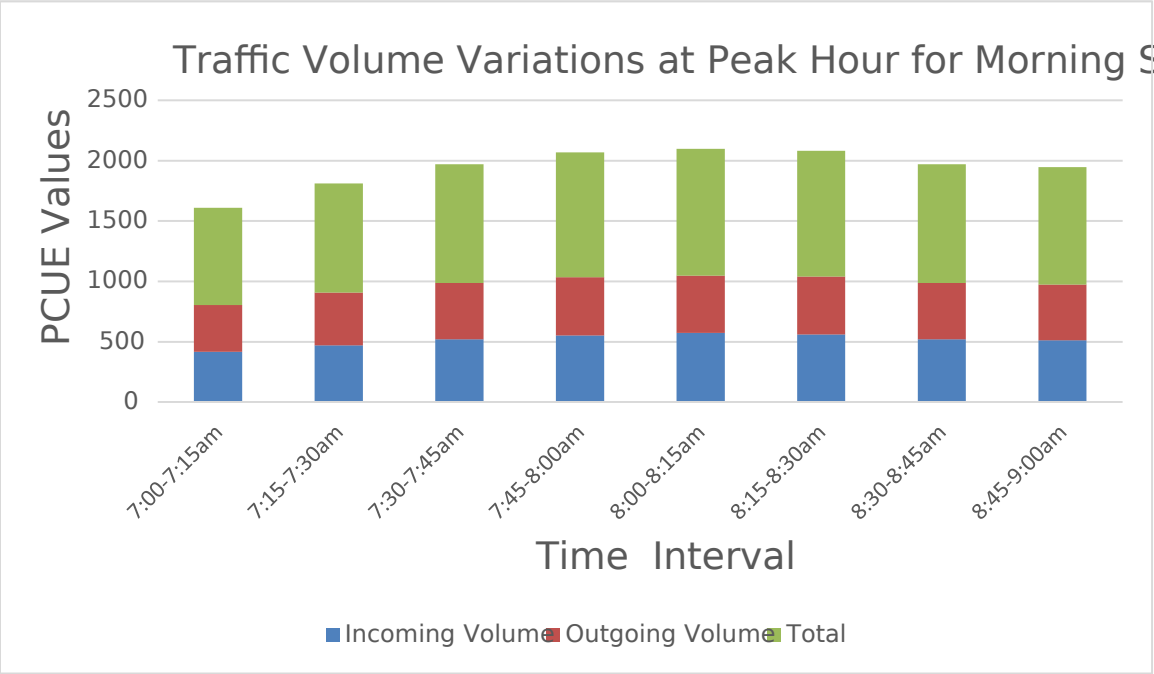

Figure 3: Graphical Representation of PCU Traffic Volume Variations Capacity for Morning

From figure 3, it is obvious that the progression of traffic volume variations occur steadily and got to the peak between 7:45am and 8:15am with 1035pcu and 1049pcu respectively. The time interval for the highest traffic volume for the whole session could be determined between 7:30am and 8:30am with 986pcu and 1041pcu respectively. This period signifies the peak hour for the morning session where congestion occurred. Within this period, the highest incoming vehicles volume occurred between the time interval of 8:00am and 8:15am with 572pcu but that of th and 8:00am with 484pcu. The lowest outgoing and incoming vehi the same time interval of 7:00am and 7:15am w

However, figur Each time interval consists of t presents incoming vehicles, r

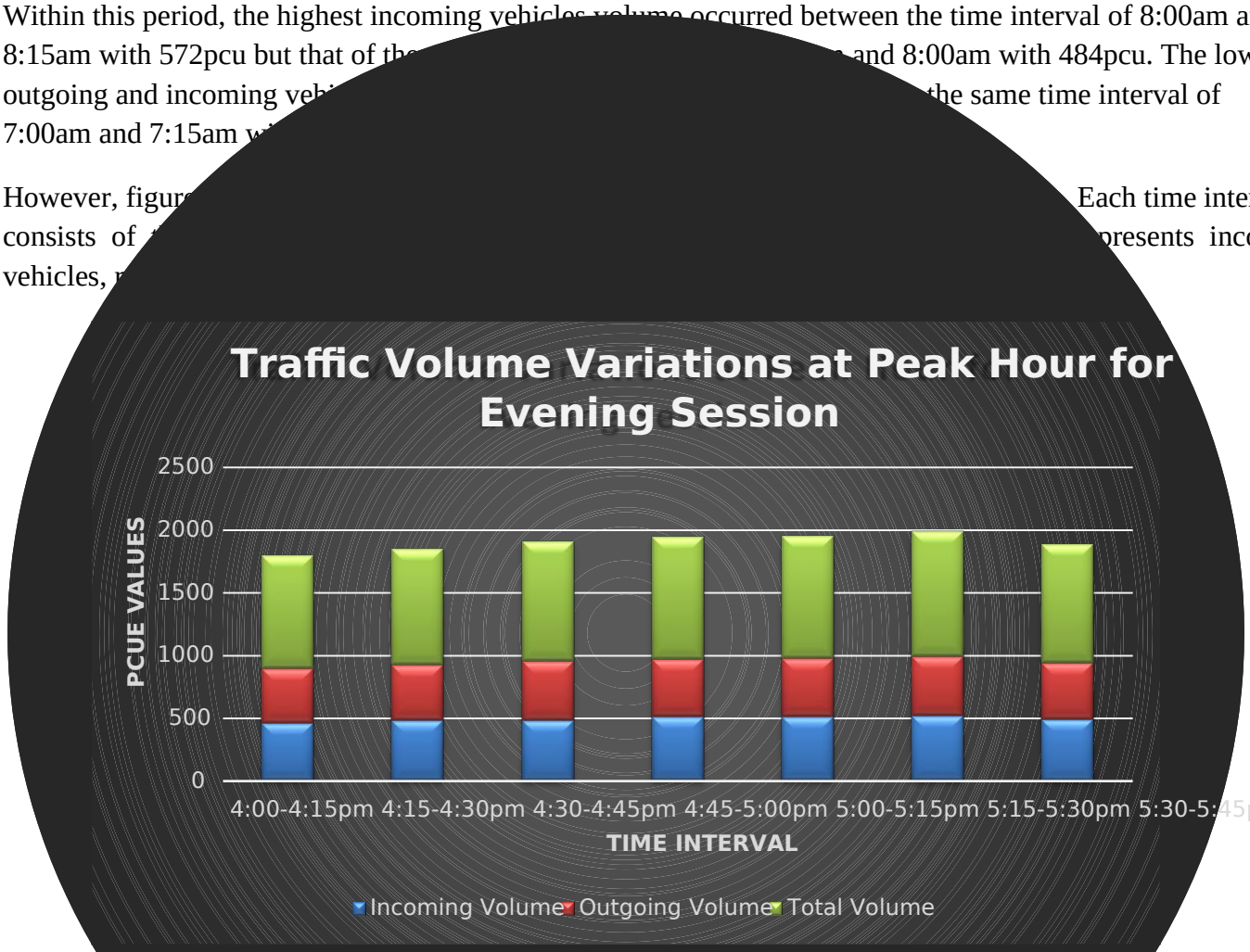

Fig ening

From figure 4, ranges between 460pcu and 491p ffic volume had a single pattern ranges traffic volume for the whole session could be de and 994pcu respectively. This period describes the peak hour fo occurred. Within this period, the highest incoming vehicles volume occurred between the time interval of 5:00pm and 5:30pm with 521pcu. This was the same time interval for the outgoing vehicles which has 473pcu. The lowest outgoing and incoming vehicle volume occurred during off peak hours and at the same time interval of 4:00pm and 4:15pm with 438pcu and 460pcu respectively. This period constitutes time for civil servants heading home from work and some business offices close for the day. [4], [5].

4.0 CONCLUSION AND RECOMMENDATIONS

Following the objectives of this study and the findings through field survey, it was discovered that the traffic composition of Oba Adesida road, Akure consists majorly of taxis, motorcycles/tricycles, buses, and trucks. These trucks were classified further according to the number of axles such as 2-axle, 3-axle, 4-axle and 5-axle trucks but the traffic was dominated by taxis, motorcycles and buses [11].

Oba Adesida road has the peak hour (PH) between 7:30am and 8:30am, then 4:30pm and 5:30pm. The peak hour volume (PHV) of 4111pcu and 3894pcu were determined for morning and evening during peak hours. The average of the PHV was 4003pcu. The Peak Hour Factor (PHF) was determined to be 0.9797. The study reveals a huge congestion level, with traffic volume ranging between 13,908 to 25,788pcu/day. The volume of the traffic per hour and per day discovered through field survey shows that the road was a very busy road. This data confirmed the practical functions of the road to the people of Akure and environs. Practically this road serves as a feeder road that connects other notable roads in Akure city. The road is surrounded by the main commercial hub and the largest market of the city. There were few poor traffic signals at some designated areas along this road and these few traffic signals were already defective and no longer in good operating condition. There was little control of traffic by government traffic wardens/officers because the public transport drivers were always in hurry. Their effort was not enough to eliminate traffic congestions at peak hour of the day on this road.

It is therefore recommended that defective traffic signals should be removed and replaced with good optimized signal operating system. This will help in no small measure to alleviate congestion and improve traffic flow of the road. Trading and hawking at road corridors, shoulders and walkways should be discouraged in this area, while adherence to the strict use of existing terminal facilities such as bus shelter/ stations at various bus-stops, lay–bys for loading and offloading passengers, should be enforced. More car parks should be constructed while the use of existing Car park should be encouraged.

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