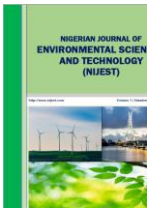
Nigerian Journal of Environmental Sciences and Technology
(NIJEST)
www.nijest.com
ISSN (Print): 2734-259X | ISSN (electronic): 2734-2603
Vol 8, No. 1 March 2024, pp 76 – 86



Determinants of Off-Peak Traffic among Commuters in Ibadan North Local Government Area, Oyo State, Nigeria

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https://doi.org/10.36263/nijest.2024.01.15

ABSTRACT

This study examines off-peak traffic among Ibadan North Local Government Area commuters, Oyo State, Nigeria. The research collects primary and secondary data, with primary data gathered through questionnaire surveys and observational methods. Using Yamane's (1967) formula, the researchers determined a sample size of 400, consisting of commuters and drivers. They systematically administered 316 questionnaires to commuters along four significant corridors: University of Ibadan (UI)-Mokola, Mokola-Agodi, Bodija-Ashi, and UI-Total Garden. The analysis, conducted using SPSS and descriptive statistics, Key findings reveal significant gender disparities in off-peak commuters, with women comprising 66.8% of off-peak commuters, likely due to their combined professional and household responsibilities. Most commuters (57.6%) fall within the 21-40 age range, likely benefiting from flexible work schedules. Work-related trips dominate at 34.1%. Income influences transportation choices, as 56.3% of commuters opt for buses, the most affordable mode. The University of Ibadan emerges as the key generator and attractor of off-peak traffic. These results emphasize the need for tailored transportation policies considering commuters' socio-economic diversity and aiming to improve public transport and urban mobility in Ibadan North.

Keywords: Traffic Management, Travel Behaviour, Urban Mobility, Infrastructure Planning, Congestion Mitigation

1.0. Introduction

Transportation is pivotal in societal development, national cohesion, and economic progress (Adedeji, 2023). Peak and off-peak travel times have emerged due to changes in traffic patterns brought about by the rise of urbanization and industrialization. Historically, changes in production schedules have caused concentrated morning and evening peaks that coincide with the beginning and conclusion of the workday (Wemegah et al., 2018). The socio-cultural factors affected by this transformation include shifts in job patterns, urban sprawl, and the everyday routines of urban dwellers (Tina et al., 2018; Yoade et al., 2022).

Urbanization and industrialization are linked to traffic congestion, which is more persistent during the peak than the off-peak period (Badami, 2005; Yañez-Pagans et al., 2019; Iamtrakul and Chayphong, 2023). Sadly, this traffic congestion hampers mobility for commuters and poses economic, environmental, and social implications for urban residents (Olojede et al., 2017; Onyeneke et al., 2018). Peak periods typically witness the highest demand for transportation infrastructure, leading to congestion and inefficiencies in transportation infrastructure (Pojani and Stead, 2015). Consequently, transportation specialists and urban planners have long looked for novel ways to encourage sustainable mobility and lessen traffic through state-of-the-art research to tackle this issue.

Over the years, numerous researchers have investigated factors influencing travel behaviour among commuters. For example, in Germany, Karl et al. (2020) identified socio-demographic (e.g., age, gender, education, and Income) travel experience, motivation, and various constraints (e.g., time, financial, health, family, work, travel companions, and stress), as determinants of pleasure travel behaviour. Similarly, in

Nigeria, studies have shown that high residential density significantly influences public transport use, while high Income significantly impacts car ownership and usage (Taofiki et al. (2018). Conversely, Wale et al. (2019) believe that modal choice is influenced by delay time at terminals, travel time, and travel cost. Salau (2018) highlights the impact of socio-economic characteristics, urban form, and infrastructure levels on travel behaviour during both peak and off-peak periods in Lagos State. However, despite the rich amount of literature on travel behaviour, there still needs to be more data on the factors influencing off-peak travel behaviour, particularly in the context of global south nations like Nigeria (Yoade et al., 2020).

Hence, this study explores the determinant of off-peak traffic in Ibadan North Local Government Area of Oyo State, Nigeria. Bridging this research gap is essential because identifying peak and off-peak traffic patterns allows for better design of sustainable transportation systems (Saraçoglu et al., 2021; Yoade, 2022). Similarly, studies have shown that shifting peak-hour traffic to off-peak hours has proven effective in decongesting roads, as evidenced by a 37% increase in average traffic speed in London (Litman, 2005) and improved travel speeds in the Region of Peel (Mousavi et al., 2020; Olatunji et al., 2021) after shifting peak-hour traffic to off-peak hours.

The above studies highlight the significance of understanding travel behaviour and exploring the data in decongesting peak traffic periods while revealing the literature gap regarding determinants and implications of off-peak traffic. This gap in the research is especially noticeable when looking at developing countries, where specific urban issues like poor infrastructure and fast population expansion make planning transportation more difficult and worsen traffic congestion (Filani, 1994; Onyeneke et al., 2018; Yoade et al., 2022). The paucity of studies on off-peak travel dynamics in these environments emphasizes the need for more studies to create focused plans that optimize transportation networks and encourage sustainable mobility habits (Brons et al., 2009; Akinrinmade and Yoade, 2016; Hossain et al., 2016).

In order to fill this research gap, this study looks into the factors that influence commuters' travel behaviour in Oyo State, Nigeria's Ibadan North Local Government Area, during off-peak hours. The main goals are to determine what influences commuters' decisions to travel during off-peak hours, examine their preferences and behaviour, and evaluate how these patterns affect urban mobility. By examining these factors, the study aims to offer insightful information on urban mobility patterns and assist in creating more efficient and sustainable transportation policies. In addition to providing valuable recommendations for boosting public transit, supporting sustainable commuting patterns, and strengthening traffic management in Ibadan North LGA, the findings will deepen our understanding of off-peak travel dynamics. In the long run, this research seeks to close the gap in the literature and assist policymakers and urban planners in developing policies that improve urban mobility and citizen quality of life.

2.0 Methodology

2.1. Study Area

The study area is Ibadan North Local Government Area, Oyo state. It shares boundaries with Akinyele LGA in the Northern region, Ibadan North-East LGA in the Eastern region, and Ibadan South East in its Southern region. The Local Government Area occupies an area of about 38.92 km^2. Dozens of banks and insurance firms spread across the cityscape to service millions of inhabitants. The majority of the population within the study area is private sector employees (NPC, 2006). Many of its Civil Servants live predominantly around Bodija estate, Agbowo, Sango, Mokola, and the University of Ibadan Quarters.

Travel behaviour in Ibadan north is closely related to the existing land-use patterns, particularly the distribution of housing, employment opportunities, and recreation facilities (Filani, 1994). Traffic arises from the inhabitant's desire to have access to their places of work and residences and to utilize the various recreation, health, and social facilities available in the city (Figure 1). The various educational and health institutions and several recreational facilities, such as Ventura and the University of Ibadan Zoo, are among the traffic-generating centres in Ibadan North. Road transport provides the primary vital link between all these spatially differentiated land-use patterns (Ipingbemi, 2010)

Workplaces predominantly cluster on the northern side of the city, while residential neighbourhoods are primarily situated in the southern regions. There is a morning rush northward, and the late afternoon traffic heading southward results in heavy traffic congestion along the main routes.

Many road networks are narrow and winding, lack pedestrian sidewalks, and are in disrepair (Filani, 1994). Roads need to be better maintained, which results in road congestion and high vehicle operating costs. Street trading has taken over Road shoulders and walkways, forcing pedestrians to share road space with moving traffic. Roads have few or no traffic signs. The inter-city public transport system consists mainly of taxis and buses. These buses are in various sizes and shapes. Most of these vehicles have a good appearance with adequate navigation aids" such as mirrors and traffic lights. Different problems associated with transportation in Ibadan North LGA are traceable to the lack of physical planning and the inability to adequately control and manage public transport by the local and state governments (Adelekan, 2016; Yoade, 2021). However, there has been a significant improvement in the road network and circulation since 2009 when U.I-Sango-Mokola-Adamasingba, which is 8.8km and Mokola-Total garden-Agodi-gate which is 4.4km have been dualized to complement the existing Sango-Eleyele road which is 3.2km and U.I-Secretariat-Total garden road which is 9.2km (Department of works, Ibadan North Local Government, 2016).

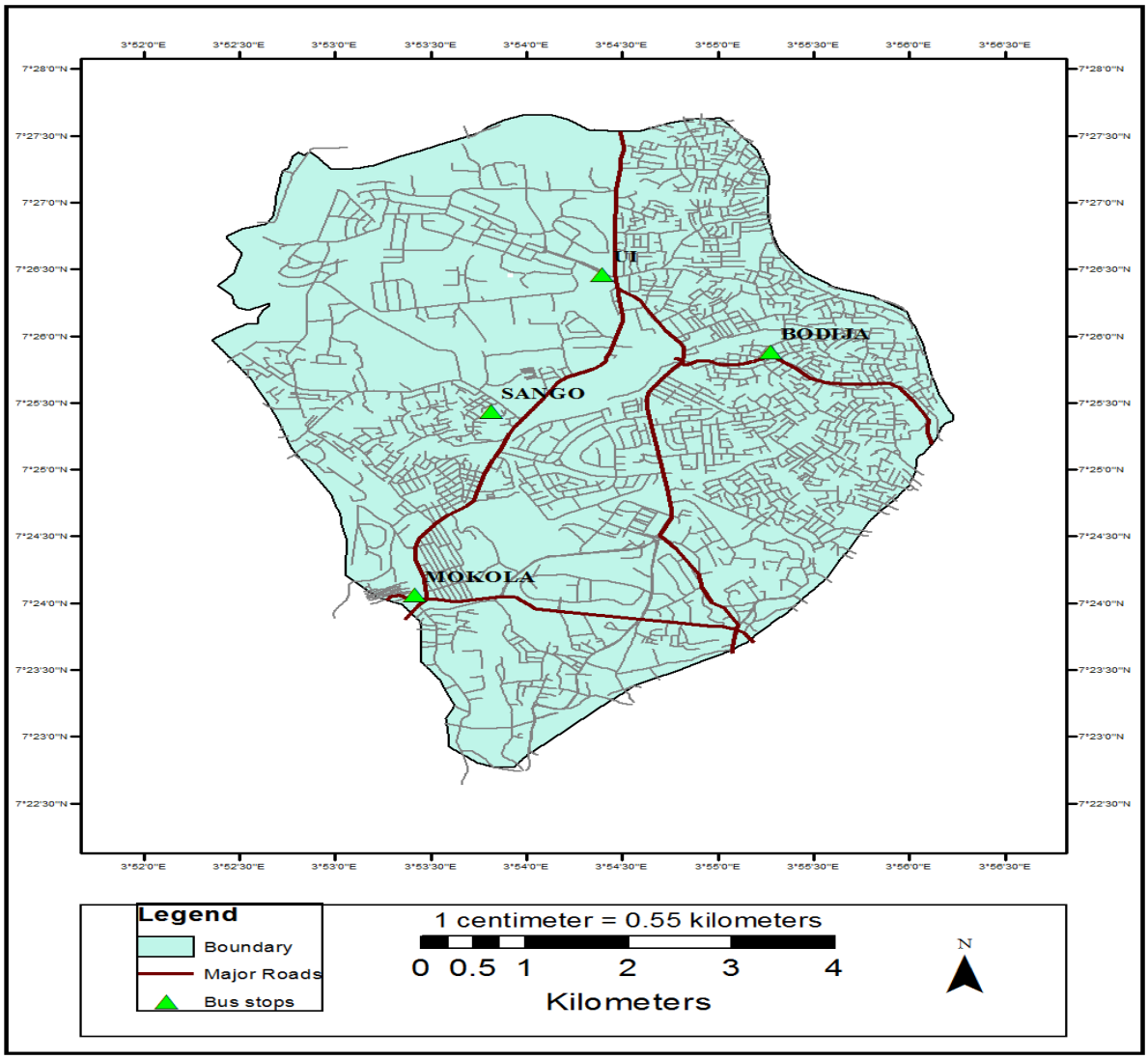

Figure 1. Ibadan North Showing the Major Bus Terminals

2.2 Materials

For this study, the researcher used a survey research approach to collect data. Primary data was collected through both questionnaire surveys and observational methods. The projected population figures for Ibadan North in 2020 were obtained by applying average growth rates of 3.2% to 302,271 the 1991 population of Ibadan North (NPC, 2006). Therefore, we arrived at the population figure of 764,578.

Furthermore, Yamane's (1967) formula was used to determine a sample size 400, including commuters and drivers. The study employed a systematic sampling method in the administration of 316 questionnaires to commuters along the four significant corridors within Ibadan North (University of Ibadan (UI)-Mokola, Mokola-Agodi, Bodija-Ashi, and UI-Total Garden).

Yamane's (1967) formula for calculating sample size is

$$n = \frac{N}{1+N(e^2)} \quad (1)$$

Where:

- **n** = required sample size
- **N** = population size
- **e** = margin of error (commonly 0.05 for a 95% confidence level)

For a population size (N) of 764,578 and assuming a margin of error (e) of 0.05 (which is common), the calculation would be:

$$n = \frac{764{,}578}{1 + 764{,}578\ (0.05^2)}$$

$$n = \frac{764{,}578}{1912.445} = 399.75$$

=400

2.2. Methods

The data obtained from the questionnaires were analyzed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics were also employed to analyze the results of the administered questionnaires.

3.1. *Socio-Economic Characteristics of the Commuters*

The socio-economic characteristics of the commuters were analyzed by considering general information such as sex, age, marital status, educational qualification, occupational status, Income, and household size. The data gathered from a sample of 316 respondents is presented in Table 1, providing insights into the overall profile of the participants.

Table 1 indicates that 66.8% of the commuters were female, while 33.2% were male. The analysis provides valuable insights into the demographic characteristics of off-peak commuters. The result indicated that female commuters were 33.6% more than the male commuters. This gender distribution could be attributed to changes in social dynamics, such as more inclusion of females in the workforce, which have contributed to increased transportation infrastructure demand among females. Similarly, the female gender is attributed to some women's gendered division of household work in addition to their corporate jobs or business. Hence, women often have multiple tasks and activities. As a result, women are more likely to have more non-work-related trips to attend during off-peak hours (Ng and Acker, 2018). However, gender is one of the key socio-demographic variables influencing travel behaviour, but it is often the least understood. Understanding travel behaviour by gender will help to design transport policies that are efficient and equitable (Ng and Acker, 2018).

Regarding age distribution, 18.4% of off-peak commuters were younger than 20, 57.6% fell within the 21-40 age range, and 5.1% were above 60. This result suggests that many respondents are within the active working-age population. The predominance of commuters falling within the active working-age population can be attributed to Travel frequency decreasing with age (Sundling et al.,2016). Furthermore, the

population within the active age is in the early to mid-stages of their careers. They may also benefit from flexible work arrangements, enabling them to commute within and outside traditional peak hours. Additionally, lifestyle preferences, including prioritizing convenience and accommodating personal commitments, may drive their choice to commute during off-peak times (Van Acker et al., 2016). Understanding these dynamics is crucial for transportation planners to effectively tailor strategies that meet the diverse needs of commuter demographics.

Marital status analysis reveals that 54.1% of respondents are single, 42.4% are married, and 3.5% are widows or widowers. The analysis of marital status reveals that a significant portion of off-peak commuters are single. The result can be attributed to several factors. Firstly, single individuals may have greater flexibility and independence in their travel choices than married individuals, who may need to consider family commitments and schedules. This flexibility could lead to a higher likelihood of opting for off-peak travel times. Additionally, single individuals may be more inclined to seek cost-effective transportation options, such as public transit or off-peak travel, as they do not have the financial support or shared expenses typical of a dual-income household. Overall, the higher proportion of single individuals among off-peak commuters suggests that demographic factors and economic considerations play a significant role in shaping travel behaviour and mode choice (Van Acker et al., 2016; Zhang et al., 2023).

Occupation-wise, 54.7% work in the private sector, 9.8% are civil servants, 11.1% are unemployed, 22.8% are students, and 1.6% did not specify their occupation. It is noteworthy that the majority of the off-peak commuters are workers. However, many of the respondents are workers in the private sector. The diversity in occupational status highlights the varied employment situations among off-peak commuters. This result could be attributed to the Changes in working patterns, such as increases in part-time jobs and self-employment, which now challenge the traditionally held assumptions that work activities are fixed in time and space (Wemegah et al., 2018). Similarly, according to (Faggio and Overman, 2014), the private sector is the highest employer of labour.

Table 1: Socio-Economic Characteristics of the Commuters

Demographic Variables	Categories	Frequency (n=316)	Percent (%)
Gender	Male	105	33.2
	Female	211	66.8
Age of Respondent	Below 20	58	18.4
	21-40	182	57.6
	41-60	60	19.0
	Above 60	16	5.1
Marital Status	Single	171	54.1
	Married	134	42.4
	Widow/Widower	11	3.5
Educational Qualification	Primary	16	5.1
	Secondary	105	33.3
	Tertiary	195	61.7
Occupational Status	Student/Apprentice	72	22.8
	Unemployed	35	11.1
	Civil Servant	31	9.8
	Private Sector	173	54.7
	Others	5	1.6
Average Income (₦)	Below 10,000	89	28.2
	10,001-30,000	103	32.6
	30,001-50,000	23	7.3
	50,001-70,000	44	13.9
	70,001 and above	57	18.0
Household Size	Below 3	66	20.9
	4-6	197	62.3
	7-9	32	10.1
	10 and above	21	6.6
	Total	**316**	**100**

Respondent monthly income distribution indicates that 28.2% earn less than 10,000, 32.6% earn between 10,001 – 30,000, 7.3% earn between 30,001-50,000, 13.9% earn between 50,001 – 70,000, and 18% earn above 70,000. The income distribution among off-peak commuters, particularly the significant proportion earning less than or equal to the #30,000 monthly minimum wage, reflects a concerning economic reality for a substantial population segment. This finding underscores the prevalence of low-wage employment, and many commuters face financial constraints. Wemegah et al. (2018) believed that the respondents' socio-

economic status would significantly impact their travel because it will facilitate their easy transition from origin to destination. Furthermore, Litman (2005) thought that Income influences the choice of public transportation. Furthermore, the household size analysis in Table 1 shows that 20.9% have below three people, 62.3% have 4 to 6 people, 10.1% have 7 to 9 people, and 6.6% have above ten people.

3.2 Travel Behaviour

The travel behaviour of the commuters was analyzed by considering general information such as waiting time, distance travelled, trip purpose, transportation challenges, modal choice, factors influencing modal choice, and modal split by sex. The data gathered from a sample of 316 respondents is presented in Table 2, providing insights into the overall profile of the participants.

Table 2. Travel Behaviour of Commuters

Variable	Category	Frequency (n = 316)	Percent (%)
Influence of Social and Economic Characteristics on Travel Behaviour	Yes	216	68.4
	No	100	31.6
Waiting time	Below 5 minutes	76	24.1
	5-10 minutes	123	38.9
	10-15 minutes	84	26.6
	15-20 minutes	12	3.8
	20 minutes and above	21	6.6
Distance Travelled	Below 3 km	82	25.8
	3 km - 6 km	71	22.6
	6 km - 9 km	86	27.2
	9 km Above	77	24.4
Trip Purpose	Work	108	34.2
	Health	18.6	5.9
	Leisure	32	10.1
	Shopping	32	10.1
	Education	72.4	22.9
	Social function	43	13.6
	Other	10	3.2
Transportation challenges	Yes	238	75.3
	No	78	24.7
Modal split	Bus	178	56.3
	Taxi	84	26.6
	Tricycle	54	17.1
Total		316	100

As displayed in Table 2, most respondents (68%) indicated that socio-economic characteristics influence their travel behaviour, while the remaining (32%) stated otherwise. The waiting time was varied among respondents, with most (39%) waiting between 5 to 10 minutes, 26.6% waiting 10 to 15 minutes, and 24% waiting below 5 minutes. A smaller proportion reported waiting 15 to 20 minutes (3.8%), while 6.6% waited 20 minutes and above. The majority (39%) waiting between 5 and 10 minutes suggests that many commuters experience moderate waiting times. However, a substantial proportion (26.6%) of waiting 10 to 15 minutes highlights the prevalence of slightly more extended waiting periods, which may be influenced by factors such as limited service coverage in certain areas. Addressing challenges associated with longer waiting times, such as improving service frequency, optimizing route planning, and enhancing infrastructure capacity, can enhance the overall commuting experience and promote sustainable mobility within the community. Furthermore, table 2 also showed that many commuters travel the shortest distance, with significant portions covering distances between 6km to 9km (27.1%) and below 3km (25.8%). Nearly a quarter (24.5%) of the respondents travelled distances of 9km and above, while 22.6% travelled between 3km and 6km. Consequently, commuters were almost evenly distributed across the various categorized distances. Similarly, respondents reported various trip purposes, the most common being work-related trips (34.1%). Education-related trips followed closely (22.9%), while health-related trips accounted for 18.6%

of reported trip purposes. Other purposes included leisure (10%), shopping (10.2%), social functions (13.7%), and others (3.2%). A high number of work trips could be attributed to the fact that the highest numbers of commuters are working class, according to Table 1. Most respondents (75%) reported facing transportation challenges commuting during off-peak periods, while a minority (25%) indicated otherwise. Modal split among respondents showed that the bus was the most utilized mode of transportation (56.3%), followed by taxis (26.6%) and tricycles (17.1%). Similarly, a significant number of respondents chose the bus. This result could be attributed to the fact that many commuters earn a sum of #30,000 or less.

The Figure 2 reveals that respondents consider cost (37.7%) as the most influential factor in their transportation choices, followed by availability (32%) and convenience (23%). Less prominent factors accounted for 7%. This finding underscores the significance of affordability in a region where most of the population falls within low- to middle-income brackets. The importance of availability suggests that transportation services may be unreliable, while the emphasis on convenience highlights the need for improved infrastructure. These findings align with Paulley et al. (2006), who noted that cost directly affects the demand for public transportation, particularly in low-income regions. Thus, enhancing affordability, increasing transport availability, and upgrading infrastructure are critical for improving the commuting experience.

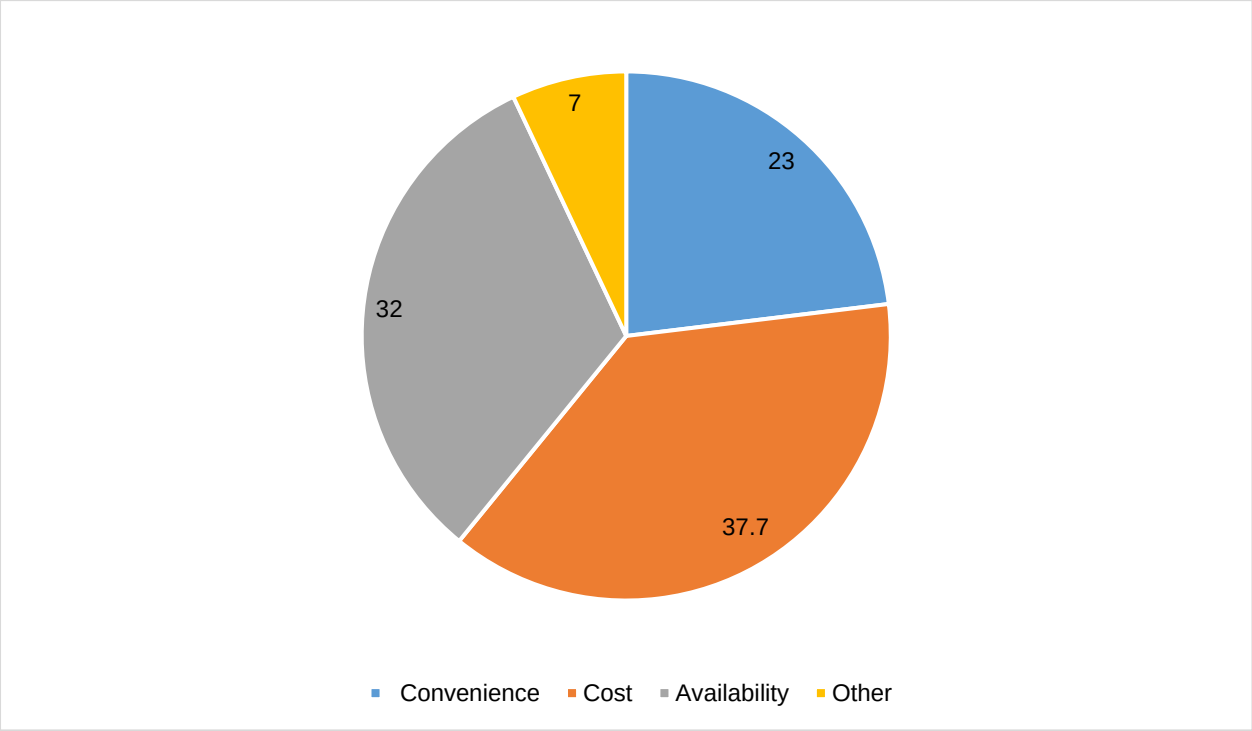

Figure 2: Factors Influencing Modal Choice

The distribution of transportation modes varied between males and females, and Figure 3 showed that females showed slightly higher usage rates for buses (58.5%) and tricycles (18%) compared to males (52% and 15%, respectively). However, males exhibited higher usage rates for taxis (33%) than females (23.5%). This modal choice disparity may stem from socio-cultural norms, individual preferences, and practical considerations. According to Williams (2023), males earn more than females; hence, this Income could have affected their transportation mode choice.

Similarly, Figure 2 already revealed that the primary determinant of transportation choice was identified as cost. Hence, female modal choice could be influenced by concern for affordability and safety, while males may opt for taxis for convenience and flexibility. Furthermore, Adeel (2017) thinks that gender roles and cultural expectations may also influence transportation choices. Understanding these dynamics can inform interventions for promoting inclusive and sustainable transportation options.

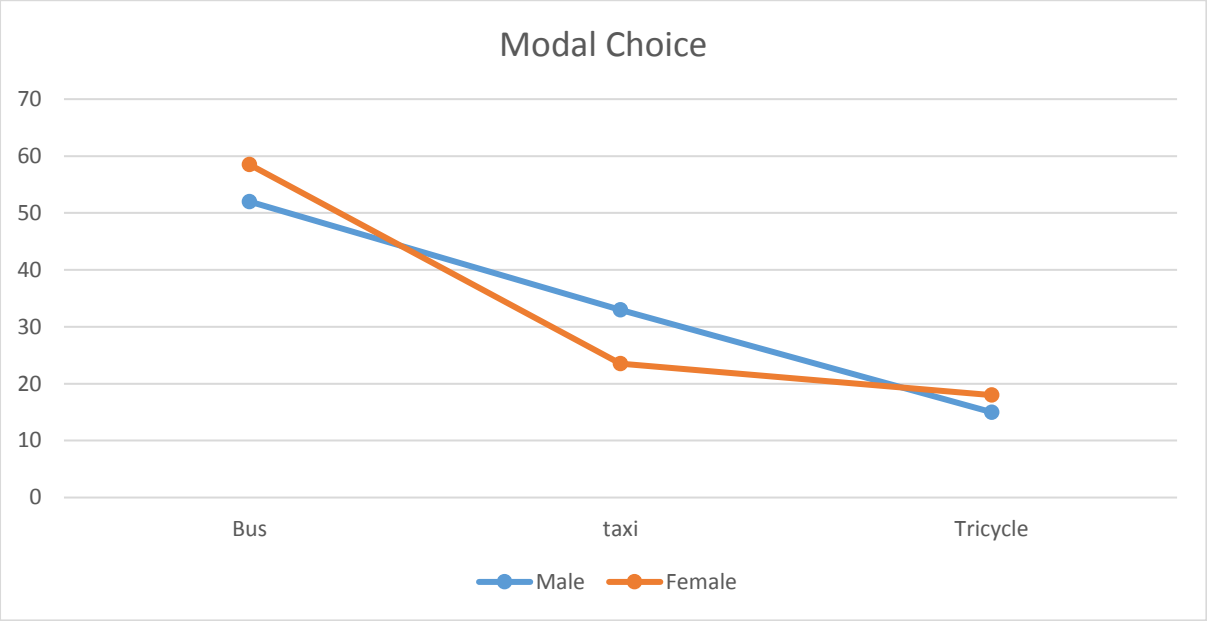

Figure 3: Modal Choice

Trip Origin and Destination

Trip Origin-destination provides direct information for transport planning purposes regarding how traffic is distributed among the Commuting population in the study area (Wemegah et al., 2018). The destination of a trip is also the origin of the following trip. The last trip of the day ends at the origin of the first trip (Lee and Hickman, 2014). Figure 4 revealed that the analysis of trip distribution across different locations indicated that, the highest percentage of the respondents' origin was UI, which is 29.4%, followed by Sango, with respondents of 20.9%, and the lowest percentage of respondents trip origin was Ashi with 3.2%. The highest percentage of respondents' destinations was also UI with 25.6%, followed by Sango with 21.2%, and then the lowest was Ashi with 3.8%.

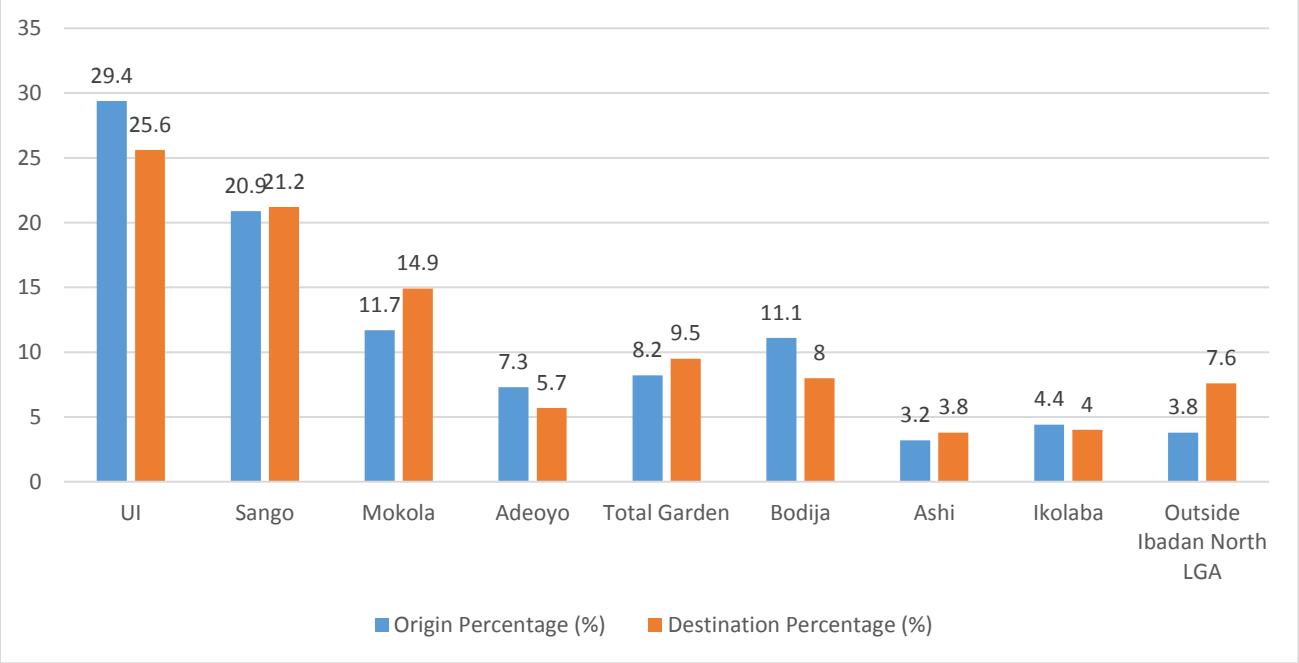

Figure 4: Trip Origin and Destination

Figure 4 revealed that the UI area generated and attracted the highest traffic volume than every other Area, and Ashi generated and attracted the lowest amount of traffic during off-peak periods. Moreover, the reason

could be related to this area's dominant land use type; according to Boeing (2018), there is a significant relationship between urban form and traffic generation.

4.0. Conclusions

This study investigated the determinants of off-peak traffic among commuters in Ibadan North Local Government Area, Oyo State, Nigeria. The findings revealed that socio-economic characteristics, such as gender, age, marital status, occupation, and Income, significantly influence travel behaviour during off-peak hours. Specifically, female commuters, individuals within the active working-age group, and those with lower income levels were more likely to engage in off-peak travel, with cost, availability, and convenience being key factors influencing their transportation choices. This study centred on understanding the dynamics of off-peak traffic, which is crucial for designing sustainable transportation systems and alleviating traffic congestion.

The findings underscore the importance of tailoring transportation policies to the diverse needs of commuters, particularly in urban areas facing rapid population growth and infrastructural challenges. The implications of this research are significant for urban planners and policymakers. By understanding the factors driving off-peak travel, targeted interventions can be developed to improve public transportation, reduce traffic congestion, and promote sustainable mobility. Additionally, recognizing demographic trends in off-peak travel can lead to more equitable transportation policies that cater to all commuter groups. However, this study has certain limitations. The focus was limited to Ibadan North LGA, and while the sample size was statistically significant, it may not fully capture the diversity of travel behaviour across other regions. Future research should explore off-peak travel dynamics in different geographical contexts and consider additional variables, such as environmental factors and technological advancements in transportation.

In light of these findings, it is recommended that transportation policies in Ibadan North LGA prioritize improving public transport infrastructure, particularly during off-peak hours, and the socio-economic characteristics of commuters should be considered in planning. Enhancing the frequency and reliability of public transport during off-peak hours could also encourage more people to shift their travel times, thereby reducing peak-hour congestion. In conclusion, this study provides valuable insights into the determinants of off-peak traffic in Ibadan, North LGA, contributing to the broader understanding of urban mobility in developing countries. By addressing the identified challenges and implementing the recommended strategies, urban planners and policymakers can foster more efficient and sustainable transportation systems, ultimately improving the quality of life for all residents.

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Cite this article as:

Faturoti, H., Ipingbemi, O., Yoade, A., Atoro, T., Atoyebi, O. and Musibau, L. 2024. Determinants of Off-Peak Traffic among Commuters in Ibadan North Local Government Area, Oyo State, Nigeria. *Nigerian Journal of Environmental Sciences and Technology*, 8(1), pp. 76-86. https://doi.org/10.36263/nijest.2024.01.15