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Socio-Economic Impacts and Traffic Flow Characterization Along the Apete–Fanawole Peri-Urban Corridor, Ibadan, Nigeria: A Preliminary Exploratory Study

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Abstract
Rapid, unplanned peri-urban growth around The Polytechnic Ibadan has intensified traffic congestion along the Apete–Fanawole Junction corridor in Ido Local Government Area, Ibadan, Nigeria. This preliminary exploratory study characterised traffic flow and assessed the perceived socio-economic impacts of congestion along the corridor, as no prior quantitative traffic-flow baseline exists for this rapidly urbanising peri-urban fringe, in contrast to well-studied Ibadan arteries such as Dugbe, Iwo-Road and Ojoo.
A traverse survey (50 m metal tape and Global Positioning System/Google Earth cross-referencing) established a 630.15 m origin–destination network between three reference nodes. Manual counts of six vehicle classes were conducted over three days (Sunday, Monday and Friday) during morning (07:00–08:30 h) and evening (18:00–19:30 h) peak sessions on both corridor segments, and converted to passenger car units (PCU) to estimate volume-to-capacity (V/C) ratios and Level of Service (LOS). Fifty structured questionnaires (25 per segment) were administered to capture perceived causes and socio-economic impacts of congestion; given that Yamane's formula indicates a minimum of approximately 399 respondents is required for a population of 103,261 at 5% error, this sample is explicitly treated as a preliminary/pilot dataset. A Chi-square test of independence was used to examine the relationship between day-of-week congestion pattern and reported delay duration.
Raw counts ranged from 531 to 884 vehicles per 1.5-hour session; converted to PCU/h and evaluated against an estimated practical capacity of 927 PCU/h, both segments operated mostly at LOS A, rising to LOS B only in the Sunday evening (V/C = 0.68) and Monday evening (V/C = 0.62) peaks. Respondents nonetheless attributed frequent, severe delay to roadside/double parking (78% agreement), uncontrolled commercial infrastructure siting (86%) and inadequate car-park provision (84%) — point-specific, junction-adjacent factors rather than link-capacity constraints. A Chi-square test of independence between day of congestion and delay duration was not statistically significant ($\chi^2 = 3.79$, $df = 6$, $p = 0.70$), and a proportion test of overall perceived socio-economic impact approached but did not reach significance at $\alpha = 0.05$ ($z = 1.91$, $p = 0.056$), consistent with the sample being under-powered.
The discrepancy between acceptable mid-block LOS and the severe delays reported by road users indicates that congestion on this corridor is driven principally by localised friction at unsignalised junctions — informal parking, hawking and unregulated commercial development — rather than by a corridor-wide capacity deficit. Interventions should therefore prioritise junction channelization, off-corridor parking relocation and setback enforcement over blanket carriageway widening. A confirmatory study with an adequately powered sample ($n \geq 399$) is recommended before firm policy conclusions are drawn.
Keywords: *traffic flow characterization; passenger car unit; level of service; socio-economic impact; peri-urban corridor; Ibadan; pilot study*

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I. Introduction

Transportation infrastructure is a principal determinant of physical and economic development in towns and cities worldwide, with land and property values consistently rising faster in areas served by expanding transport networks than in areas without such improvements (Goldberg, 1970). Road networks are conventionally evaluated in terms of accessibility, connectivity, traffic density, level of service and compactness (Mannering et al., 2004), and locations that combine several transport routes at high connectivity typically enjoy a relative developmental advantage over less accessible nodes (Wyatt, 1997).

Nigeria's urban centres, including Ibadan, have experienced sustained population growth without a corresponding expansion of road infrastructure, producing traffic congestion that the Texas Transportation Institute and Federal Highway Administration (2005) define as a relative phenomenon arising whenever actual roadway performance falls short of road users' expectations. In Ibadan specifically, chronic congestion has long been documented along major nodes such as Dugbe, Iwo-Road, Ojoo, Mokola and Challenge (Ogunsesan and Akanmu, 2010), where poor intersection geometry, haphazard on-street parking, uncoordinated commercial development and inadequate traffic-control devices interact to degrade free traffic flow (Popoola et al., 2013).

A substantial body of Ibadan-focused traffic literature has therefore concentrated on the historic central business district and its immediate radial corridors. Considerably less quantitative attention, however, has been directed at the rapidly urbanising peri-urban fringe west of the city, particularly the Apete axis in Ido Local Government Area. This corridor has undergone accelerated, largely unplanned commercial conversion driven by its proximity to The Polytechnic Ibadan, with residential plots increasingly repurposed into shops, filling stations and motor parks (Adedayo and Akinremi, 2015). Despite this, the Apete–Fanawole Junction arterial — a critical link connecting Apete to the Awotan, Ayegun and Sango/Polytechnic axes — lacks a documented traffic-volume baseline expressed in standard engineering units, and lacks a structured assessment of the socio-economic costs its congestion imposes on residents. This represents a clear gap in the literature: while the causes of congestion in Ibadan's core have been well characterised, comparable operational and socio-economic data for its peri-urban arterial roads remain scarce, limiting evidence-based planning for these fast-growing fringe communities.

This study addresses that gap by combining field-based traverse surveying, manual traffic counting converted to passenger car units (PCU), and structured questionnaire administration, to characterise traffic flow and assess the perceived socio-economic impacts of congestion along the Apete–Fanawole Junction arterial, Ido Local Government Area, Ibadan, Oyo State. Given sample-size constraints discussed in Section 2.5, the study is explicitly presented as a preliminary exploratory investigation intended to establish a baseline and inform the design of a subsequent, adequately powered confirmatory study.

1.1 Aim and Objectives

The aim of this preliminary exploratory study was to characterise traffic flow and assess the perceived socio-economic impacts of road traffic congestion along the Apete to Fanawole Junction corridor, Ido Local Government Area, Ibadan, Oyo State. The specific objectives were to: (i) determine the arterial road network pattern and geometry of the study area; (ii) characterise traffic flow within the corridor in standard engineering units (PCU) and estimate the prevailing Level of Service; (iii) generate peak-period traffic volume data for both corridor segments; (iv) identify the perceived causes and socio-economic impacts of traffic congestion from the road-user perspective; and (v) recommend context-specific engineering interventions grounded in the measured corridor geometry.

1.2 Research Hypotheses

H01: Road traffic congestion has no significant socio-economic impact on road users in the study area; Hi1: Road traffic congestion has a significant socio-economic impact on road users in the study area. H02: There is no significant relationship between the temporal (day-of-week) pattern of the road traffic system and the delay duration experienced by road users in the study area; Hi2: There is a significant relationship between the temporal traffic pattern and the delay duration experienced by road users.

II. Materials and Methods

2.1 Study Area

The study was conducted along the Apete to Fanawole Junction arterial, a tangential road along the Apete–Ariyibi corridor in Ido Local Government Area, Ibadan, Oyo State, Nigeria. Apete lies on the north-western fringe of Ibadan, bounded to the north by the proposed Western bye-pass, to the east by The Polytechnic Ibadan, to the west by the Eleyele waterworks, and to the south by a river. The 2006 census recorded a population of 103,261 for Apete, while Ido Local Government as a whole recorded approximately 306,795 (NIPOST, 2009).

Although historically agrarian, the area has diversified into commerce, carpentry, motorcycle transport and other trades following the establishment of The Polytechnic Ibadan nearby.

The origin–destination (O–D) survey established the study corridor between latitudes 3°50'51" and 3°52'27" N and longitudes 7°26'49" and 7°27'07" E, bounded by three reference nodes: Apete Bridge Embankment and Iyana-Fanawole T-Junction (origins), and Fanawole Junction (destination), the latter forming a busy T-junction linking the Awotan–Akufo, Ayegun–Olomo and Polytechnic Ibadan–Sango axes.

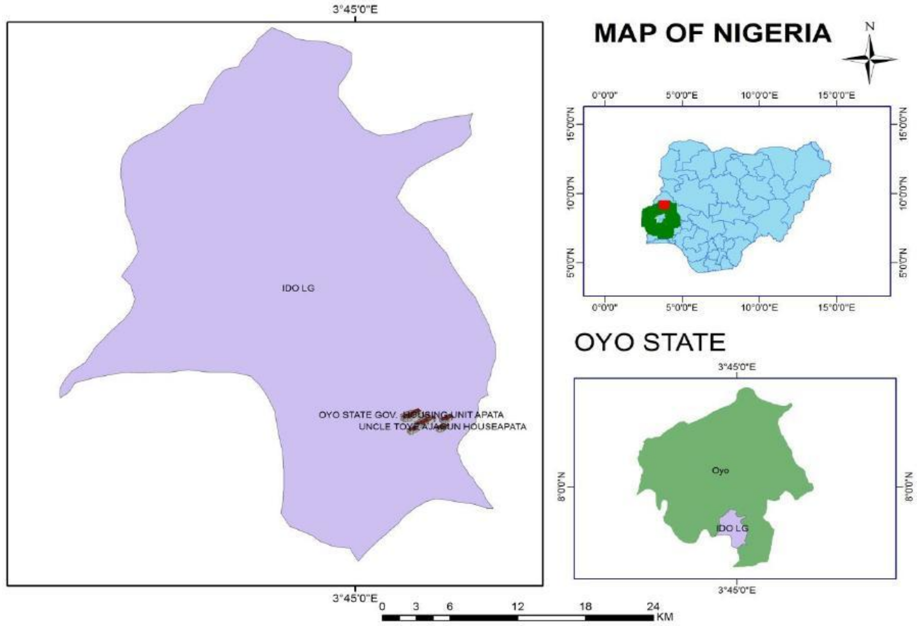

Figure 1. Location of the study area: Ibadan within Nigeria and Ido Local Government Area within Oyo State. Source: Oyo State Ministry of Lands and Housing (2015).

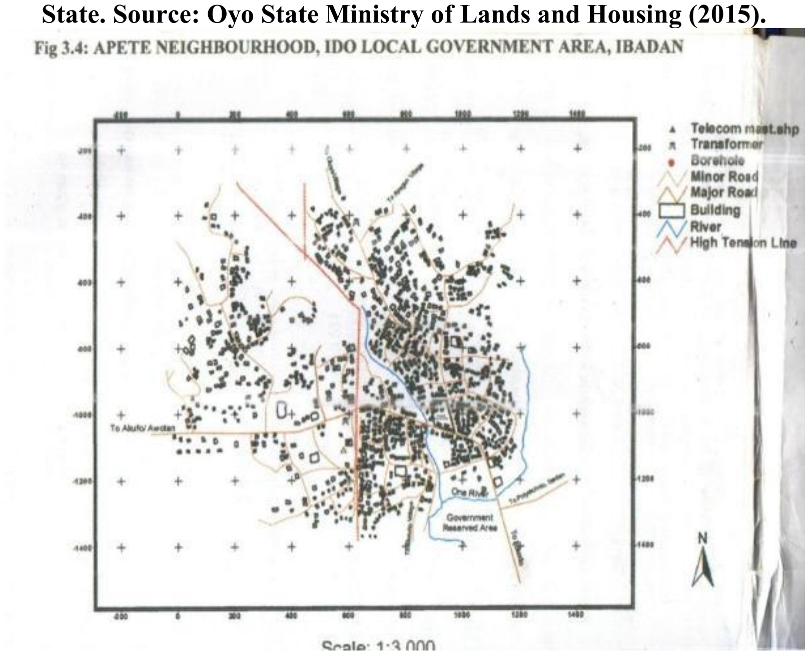

Figure 2. Base map of Apete neighbourhood showing the road network, buildings, borehole points and river within the study locality (scale 1:3,000). Source: Ministry of Land, Survey and Housing, Oyo State (2015).

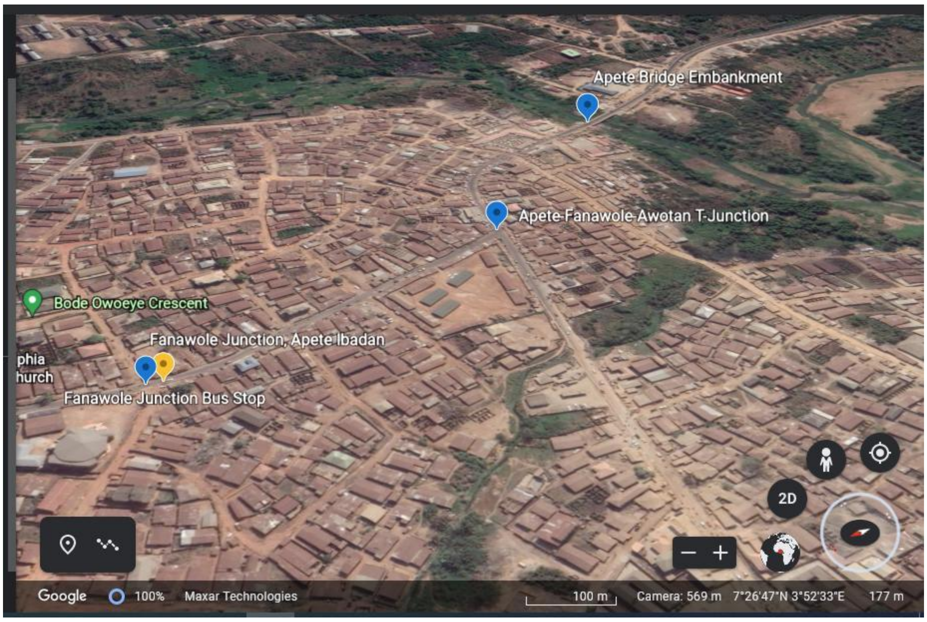

Figure 3. Aerial view of the Apete–Fanawole study corridor showing the three survey reference nodes: Apete Bridge Embankment, Apete-Fanawole-Awotan T-Junction and Fanawole Junction. Source: Google Earth (2021).

2.2 Materials and Instruments

Field geometry was obtained by traverse survey using a 50 m metal tape, hammer and nails for chainage marking, a field book, a handheld Global Positioning System (GPS) receiver, and the Google Earth Pro application for coordinate verification and route visualisation. Traffic and delay observations were recorded using an Android smartphone camera and a tripod stand for both daytime and night-time documentation. The carriageway cross-section (width) was not directly measured during the original field survey; where cross-sectional data are required for capacity analysis (Section 2.6), a reasoned assumption is stated explicitly and treated as a limitation (Section 4.1).

2.3 Data Acquisition

Data were obtained from primary and secondary sources. Primary data comprised: (i) direct geospatial observation using GPS and Google Earth to fix the coordinates of interest points; (ii) a questionnaire survey and personal interviews with traders, drivers and passersby; and (iii) manual traffic counting and delay observation at the study nodes. Secondary data were drawn from journals, conference proceedings, institutional reports and relevant web sources.

The traverse (O–D) survey was fixed on three known points — two origins (Apete Bridge Embankment and Iyana-Fanawole T-Junction) and one destination (Fanawole Junction) — with chainage marked at 50 m intervals using the metal tape, hammer and nails, and cross-referenced against GPS coordinates recorded in the field book.

2.4 Traffic Counting

Manual traffic counting was adopted following preliminary reconnaissance, being appropriate for the short, defined observation windows used in this study. Vehicles were classified into six categories: private cars, commercial cars, buses, tricycles, motorcycles and trucks. Counting was conducted over three purposively selected days — Sunday, Monday and Friday — during two 1.5-hour peak windows per day (07:00–08:30 h and 18:00–19:30 h), selected on the basis of preliminary observation of when congestion was most pronounced. Counts were taken independently on each of the two corridor segments: Iyana-Fanawole T-Junction–Apete Bridge, and Fanawole Junction–Iyana-Fanawole T-Junction.

2.5 Questionnaire Survey and Sample-Size Justification

Fifty structured questionnaires were administered by the researcher along the study route to traders, drivers and passersby, split evenly (25 each) between the two corridor segments. Two questionnaire variants were used: one addressed to shop occupiers and drivers stationed at garages/roadsides, covering respondent background, congestion timing and duration, and perceived causes; and another addressed to passersby and commercial/private vehicle drivers and passengers delayed in traffic, covering the economic and social impacts of congestion. In-depth personal interviews accompanied questionnaire administration to compensate for the reluctance of busy respondents to volunteer written information.

Applying Yamane's (1967) sample-size formula, $n = N / (1 + N e^2)$, to the 2006 Apete population of $N = 103{,}261$ at a 5% margin of error ($e = 0.05$) yields a minimum required sample of $n \geq 398.5$, i.e. approximately 399 respondents. The achieved sample of 50 respondents represents only about 12.5% of this statistically required minimum and is therefore explicitly insufficient to support confirmatory, population-representative inference. Accordingly, this study is presented as a preliminary exploratory pilot survey: all percentages and inferential test results reported in Section 3 should be interpreted as indicative trends rather than statistically generalisable population estimates, and a follow-up study with an adequately powered sample is recommended (Section 5).

2.6 Passenger Car Unit Conversion and Capacity/Level-of-Service Methodology

Raw vehicle counts (Tables 3 and 4) were converted to passenger car units (PCU) using standard equivalency factors: private car = 1.0, commercial car = 1.0, bus (minibus-type, as operated on this corridor) = 1.5, tricycle = 0.7, motorcycle = 0.5, and heavy truck = 2.5 (Table 5). Session PCU volumes were normalised to an hourly rate (PCU/h) by dividing by the 1.5-hour observation duration.

Because the original traverse survey did not record carriageway cross-sectional width, a practical capacity was estimated using the following explicitly stated assumptions, consistent with Highway Capacity Manual (HCM)-style adjustment procedures: (a) the corridor is a two-lane, two-way undivided carriageway of approximately 6.0 m total width (3.0 m per lane), consistent with photographic evidence (Plates I–V) and field notes describing the road as narrow; (b) a base capacity of 2,800 PCU/h is adopted for an urban two-lane two-way road under ideal conditions; (c) a lane-width adjustment factor of 0.86 is applied for sub-standard 3.0 m lanes (relative to a 3.5 m standard lane); (d) a side-friction adjustment factor of 0.70 is applied to reflect the heavy roadside activity documented in the field (hawking, parking, pedestrian conflict); and (e) a pavement-condition/obstruction factor of 0.55 is applied to reflect the potholes, garbage encroachment and informal parking narrowing the usable carriageway, as photographically documented (Plates I–V). The resulting estimated practical capacity is $2{,}800 \times 0.86 \times 0.70 \times 0.55 \approx 927$ PCU/h, applied uniformly to both segments given their similar cross-section and observed roadside conditions. This capacity estimate is a reasoned engineering assumption rather than a directly measured quantity, and is treated as a stated limitation (Section 4.1).

The volume-to-capacity (V/C) ratio for each session was computed as PCU/h divided by the estimated practical capacity, and mapped to a Level of Service (LOS) category using the following standard bands: LOS A ($V/C \leq 0.60$), LOS B (0.61–0.70), LOS C (0.71–0.80), LOS D (0.81–0.90), LOS E (0.91–1.00), and LOS F (> 1.00).

2.7 Statistical Analysis

Descriptive statistics (frequencies and percentages) were used to summarise questionnaire responses. Two confirmatory inferential tests were conducted. First, a Chi-square test of independence (not a goodness-of-fit test, since the objective is to test the dependency between two categorical variables rather than to compare a single variable against a known distribution) was applied to a 3 × 4 contingency table cross-tabulating day of congestion (Sunday, Monday, Friday) against reported delay duration (four categories), to test H02. The test statistic was computed as $\chi^2 = \Sigma\Sigma (O_{ij} - E_{ij})^2 / E_{ij}$, where O_{ij} is the observed cell frequency and $E_{ij} = (\text{row total}_i \times \text{column total}_j) / \text{grand total}$ is the expected frequency under independence, with degrees of freedom df = (rows – 1)(columns – 1). Second, a one-sample z-test for a proportion was used to test H01, comparing the mean respondent agreement across the four socio-economic impact indicators (Section 3.9) against a null benchmark of 50% (no majority impact), using $z = (\hat{p} - p_0) / \sqrt{[p_0(1-p_0)/n]}$. Both tests were evaluated at $\alpha = 0.05$.

III. Results

3.1 Traverse Survey and Road Geometry

Table 1 presents the geographic coordinates of the three reference nodes established along the study corridor, while Table 2 presents the traverse survey results. The total measured horizontal chainage of the corridor was 630.15 m, comprising 356.12 m between Apete Bridge Embankment and Iyana-Fanawole T-Junction, and 270.03 m between Iyana-Fanawole T-Junction and Fanawole Junction. The angular deviations recorded in Table 2 (cumulative 1'56", or 0.1611°) reflect horizontal bearing changes in the traverse route — not vertical ground inclination — and the corridor is essentially level over this short peri-urban distance; no vertical slope correction was therefore required, and the reported 630.15 m is the directly measured horizontal chainage length.

Table 1. Geographic coordinates of the study reference nodes.

S/N	Location	Latitude	Longitude
1	Origin (Apete Bridge Embankment)	3°52'27" N	7°26'49" E
2	Curve point (Iyana-Fanawole T-Junction)	3°52'27" N	7°26'56" E
3	Destination (Fanawole Junction)	3°52'27" N	7°27'07" E

Table 2. Traverse survey results for the Apete–Fanawole corridor.

S/N	Arterial/Route	Length (m)	Bearing Deviation (Δ)
1	Apete Bridge to Iyana-Fanawole T-Junction	356.12	0'07" (0.0194°)
2	Iyana-Fanawole T-Junction to Fanawole Junction	270.03	1'49" (0.1417°)
	Total measured horizontal chainage	630.15	1'56" (0.1611°)

3.2 Traffic Volume Data (Raw Counts)

Manual counts across the three survey days showed total peak-session volumes ranging from 531 to 884 vehicles (Tables 3 and 4). On the Iyana-Fanawole T-Junction–Apete Bridge segment, the highest raw count occurred on Sunday evening (884 vehicles), while on the Fanawole Junction–Iyana-Fanawole T-Junction segment, the highest raw count occurred on Monday evening (786 vehicles). Motorcycles, tricycles and commercial (shared) cars consistently outnumbered private cars across both segments, reflecting a corridor economy dominated by informal public transport rather than private motorisation (Figures 4–6).

Table 3. Manual vehicle count, Iyana-Fanawole T-Junction – Apete Bridge segment.

Day	Session	Private Car	Commercial Car	Bus	Tricycle	Motorcycle	Truck	Total
Sunday	Morning (7:00–8:30)	105	181	207	88	94	23	698
Sunday	Evening (18:00–19:30)	161	211	271	92	136	13	884
Monday	Morning (7:00–8:30)	127	79	136	96	113	23	711
Monday	Evening (18:00–19:30)	127	137	214	98	118	19	694
Friday	Morning (7:00–8:30)	100	113	197	83	124	16	633
Friday	Evening (18:00–19:30)	178	106	201	168	70	25	748

Table 4. Manual vehicle count, Fanawole Junction – Iyana-Fanawole T-Junction segment.

Day	Session	Private Car	Commercial Car	Bus	Tricycle	Motorcycle	Truck	Total
Sunday	Morning (7:00–8:30)	119	129	117	85	63	18	531
Sunday	Evening (18:00–19:30)	126	145	143	57	116	28	615
Monday	Morning (7:00–8:30)	156	221	185	78	84	28	752

Day	Session	Private Car	Commercial Car	Bus	Tricycle	Motorcycle	Truck	Total
Monday	Evening (18:00–19:30)	192	222	189	59	96	28	786
Friday	Morning (7:00–8:30)	121	123	107	75	114	29	569
Friday	Evening (18:00–19:30)	167	184	195	96	84	27	753

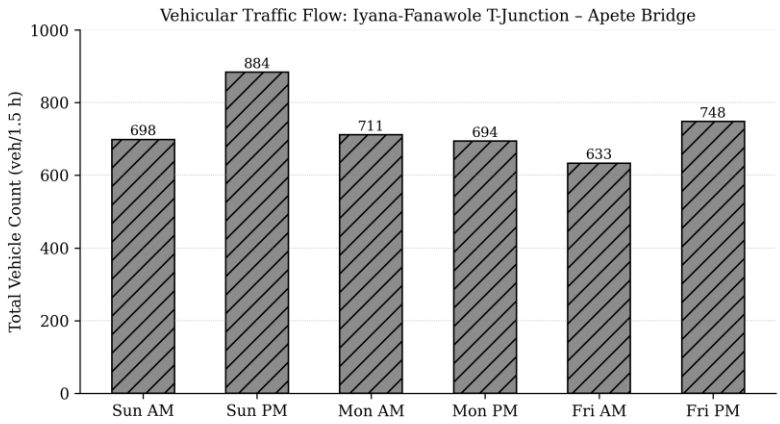

Figure 4. Total vehicular flow per session, Iyana-Fanawole T-Junction – Apete Bridge segment.

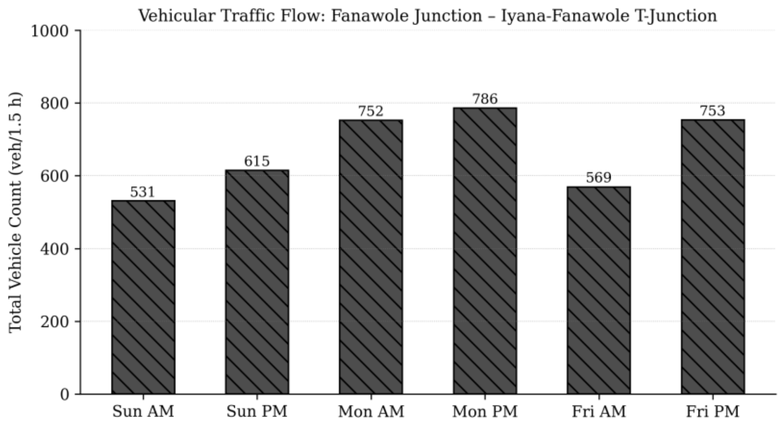

Figure 5. Total vehicular flow per session, Fanawole Junction – Iyana-Fanawole T-Junction segment.

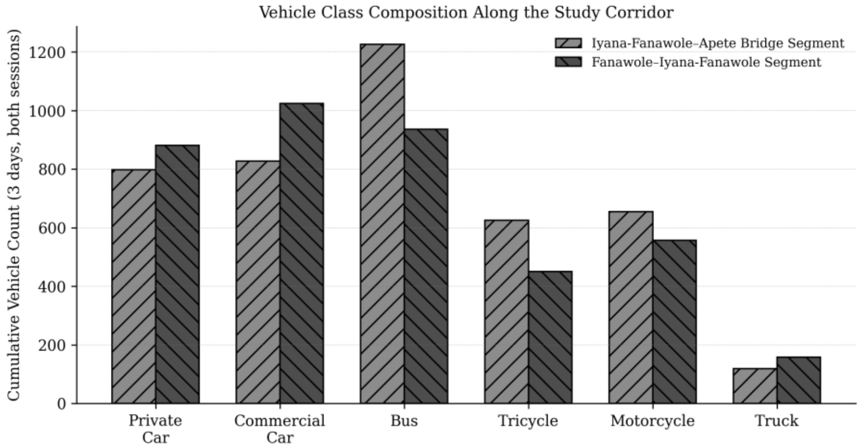

Figure 6. Cumulative vehicle-class composition across both corridor segments over the three survey days.

3.3 Passenger Car Unit Conversion and Level-of-Service Analysis

Table 5 presents the PCU equivalency factors applied, and Table 6 presents the resulting hourly PCU volumes, V/C ratios and LOS for both segments across all six survey sessions, using the practical capacity of 927 PCU/h derived in Section 2.6.

Table 5. Passenger car unit (PCU) equivalency factors applied.

Vehicle Class	PCU Factor
Private car	1.0
Commercial car	1.0
Bus (minibus-type)	1.5
Tricycle	0.7
Motorcycle	0.5
Heavy truck	2.5

Table 6. Hourly PCU volume, volume-to-capacity (V/C) ratio and Level of Service (LOS), by segment and session (practical capacity = 927 PCU/h).

Segment	Day	Session	PCU/h	V/C Ratio	LOS
Iyana-Fanawole–Apete Bridge	Sunday	Morning	508.4	0.55	A
Iyana-Fanawole–Apete Bridge	Sunday	Evening	628.9	0.68	B
Iyana-Fanawole–Apete Bridge	Monday	Morning	394.1	0.43	A
Iyana-Fanawole–Apete Bridge	Monday	Evening	506.7	0.55	A
Iyana-Fanawole–Apete Bridge	Friday	Morning	445.7	0.48	A
Iyana-Fanawole–Apete Bridge	Friday	Evening	533.7	0.58	A
Fanawole–Iyana-Fanawole	Sunday	Morning	373.0	0.40	A
Fanawole–Iyana-Fanawole	Sunday	Evening	435.6	0.47	A
Fanawole–Iyana-Fanawole	Monday	Morning	547.4	0.59	A
Fanawole–Iyana-Fanawole	Monday	Evening	571.2	0.62	B
Fanawole–Iyana-Fanawole	Friday	Morning	391.0	0.42	A
Fanawole–Iyana-Fanawole	Friday	Evening	546.8	0.59	A

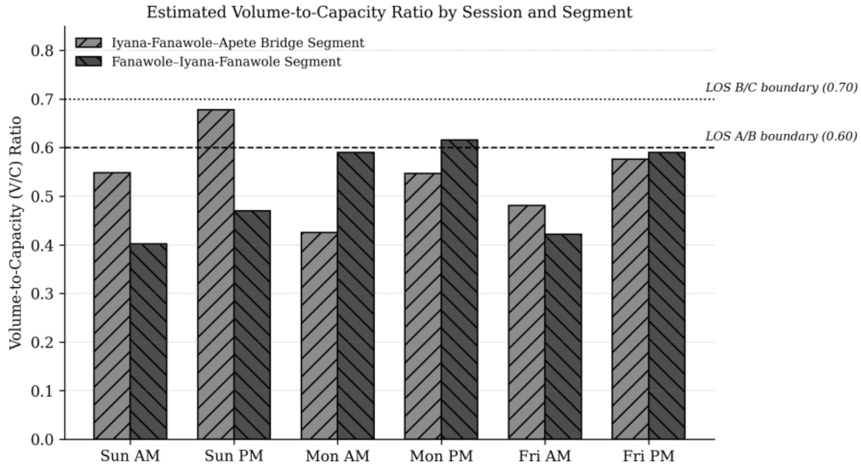

Figure 7. Estimated volume-to-capacity (V/C) ratio by session and segment, with Level of Service (LOS) boundaries marked.

Under the stated capacity assumptions, both corridor segments operate predominantly at LOS A (V/C ≤ 0.60), with only the Sunday evening session on the Iyana-Fanawole–Apete Bridge segment (V/C = 0.68) and the Monday evening session on the Fanawole–Iyana-Fanawole segment (V/C = 0.62) reaching LOS B. No session in the six observation windows reached LOS C or worse at the link (mid-block) level. This finding is discussed further in Section 4 in relation to the markedly more severe congestion reported by respondents.

3.4 Field Observations of Traffic Conditions

Direct field observation confirmed that congestion at the Iyana-Fanawole T-Junction was intensified by informal roadside trading and uncontrolled motorcycle/tricycle parking immediately adjacent to the carriageway (Plate I). Along Ayegun Road at Fanawole Junction, pavement deterioration narrowed the effective carriageway width and forced vehicles into conflicting paths (Plate II). During evening peak hours, dense motorcycle and tricycle queuing was observed beside the Philadelphia Baptist Church junction (Plate III), while both daytime and evening congestion around Apete Market (Plates IV and V) were driven by the spill-over of market activity, hawking and passenger loading directly onto the carriageway. In each case, the visible obstruction is localised and point-specific rather than distributed uniformly along the link, consistent with the LOS findings in Section 3.3.

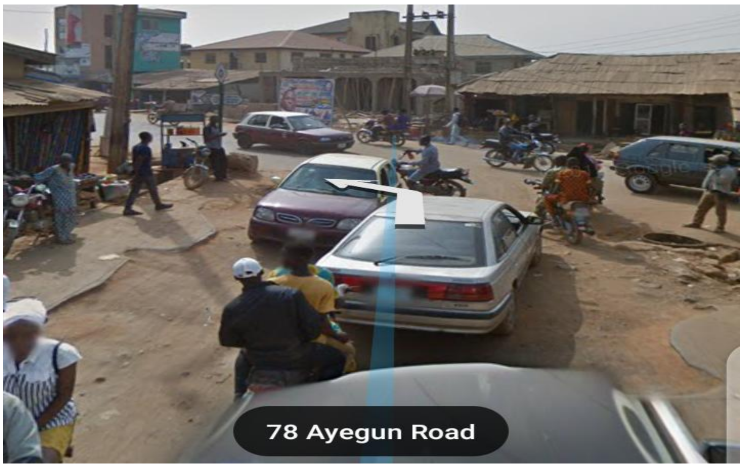

Plate I. Iyana-Fanawole T-Junction, Apete, Ibadan, showing roadside trading and vehicle queuing at the junction approach.

Plate II. Fanawole Junction, Ayegun Road, Apete, showing pavement deterioration along the study corridor.

Plate III. Evening traffic congestion beside Philadelphia Baptist Church, Fanawole Junction, Apete, Ibadan.

Plate IV. Daytime traffic congestion beside Apete Market, Apete, Ibadan.

Plate V. Evening traffic congestion beside Apete Market, Apete, Ibadan.

3.5 Socio-Demographic Profile of Respondents

Fifty questionnaires were distributed and fully retrieved (100% response rate), evenly split between the two corridor segments (Table 7). Respondents were predominantly male (58%), aged between 26 and 33 years (38%), of tertiary educational attainment (46%), and single (58%) (Table 8, Figure 8). As noted in Section 2.5, this profile describes only the 50 sampled respondents and should not be extrapolated to the wider Apete population without a larger, probability-based sample.

Table 7. Questionnaire distribution and retrieval by location.

Location	Distributed	Retrieved
Fanawole Junction	5	5
Oriare	8	8
Oriare/Apete Central Mosque	5	5

Location	Distributed	Retrieved
Iyana-Fanawole Junction	7	7
Nobility-07 Filling Station	8	8
Iyana-Idioro Junction	5	5
Apete Main Market	8	8
Apete Car Park	4	4
Total	50	50

Table 8. Socio-demographic characteristics of respondents (n = 50).

Variable	Category	Frequency	Percentage (%)
Sex	Male	29	58
Sex	Female	21	42
Age (years)	18–25	10	20
Age (years)	26–33	19	38
Age (years)	34–41	12	24
Age (years)	42 and above	9	18
Education	Primary	6	12
Education	Secondary	16	32
Education	Tertiary	23	46
Education	Post-graduate	5	10
Marital status	Single	29	58
Marital status	Married	13	26
Marital status	Widowed	8	16

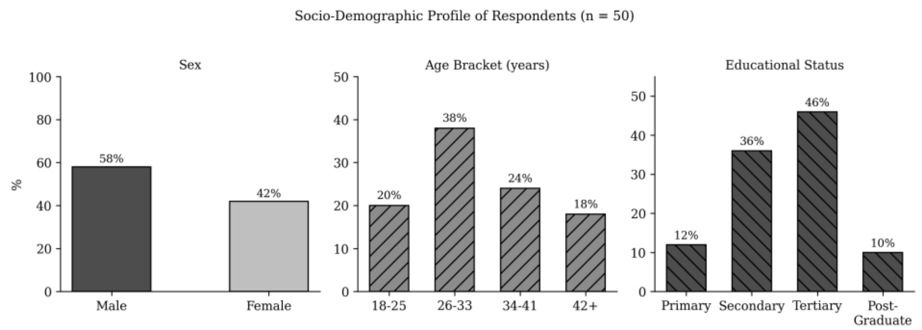

Figure 8. Socio-demographic profile of respondents (n = 50).

3.6 Traffic Delay Experience

Monday was identified by the majority of respondents (56%) as the day of worst congestion, consistent with its status as the first working day of the week. Reported delay durations were concentrated in the 21–30-minute range (40%), and congestion was most frequently experienced between 06:30 and 07:30 pm (26%) and 07:30–8:00 am (24%), coinciding with commuting periods. Sixty-four percent of respondents reported cancelling or arriving late for an appointment on 3–5 occasions because of traffic delay (Table 9).

Table 9. Traffic delay experience reported by respondents (n = 50).

Indicator	Category	Frequency	Percentage (%)
Day of worst congestion	Sunday	12	24
Day of worst congestion	Monday	28	56
Day of worst congestion	Friday	10	20
Delay duration	Up to 10 min	8	16
Delay duration	10–20 min	12	24
Delay duration	21–30 min	20	40
Delay duration	30 min and above	10	20
Peak congestion time	7:30–8:00 am	12	24
Peak congestion time	8:00–8:30 am	9	18
Peak congestion time	8:30–9:00 am	6	12
Peak congestion time	6:00–6:30 pm	10	20
Peak congestion time	6:30–7:30 pm	13	26
Missed/late appointments	3 times	23	46
Missed/late appointments	5 times	9	18
Missed/late appointments	Many times	8	16
Missed/late appointments	Several times	10	20

3.7 Inferential Statistical Analysis

3.7.1 Chi-Square Test of Independence: Day of Congestion × Delay Duration (H02)

To test H02, the reported day-of-week congestion pattern (Sunday, Monday, Friday) was cross-tabulated against reported delay duration (four categories), preserving the marginal totals reported in Table 9 (Table 10). Expected frequencies under the independence assumption were computed as E_{ij} = (row total × column total) / 50 (shown in parentheses in Table 10).

Table 10. Contingency table of observed frequencies (with expected frequencies in parentheses): day of congestion × delay duration.

Day	Up to 10 min	10–20 min	21–30 min	30 min+	Row Total
Sunday	3 (1.92)	4 (2.88)	4 (4.80)	1 (2.40)	12
Monday	3 (4.48)	6 (6.72)	13 (11.20)	6 (5.60)	28
Friday	2 (1.60)	2 (2.40)	3 (4.00)	3 (2.00)	10
Column Total	8	12	20	10	50

Table 11. Chi-square test of independence: results.

Test	χ^2	df	p-value	Decision at $\alpha = 0.05$
Day of congestion × Delay duration	3.79	6	0.70	Fail to reject H02 (independence)

The computed $\chi^2 = 3.79$ (df = 6) is well below the critical value of 12.59 at $\alpha = 0.05$, giving $p \approx 0.70$. The null hypothesis of independence (H02) is therefore not rejected: on this sample, there is no statistically significant association between day of congestion and reported delay duration. This does not necessarily mean no true relationship exists; rather, the small sample size ($n = 50$, versus the Section 2.5 requirement of $n \geq 399$) limits the statistical power available to detect an association of plausible magnitude, and the descriptive pattern (Monday accounting for the largest share of both worst-congestion reports and 21–30-minute delays) remains a reasonable candidate for confirmation in an adequately powered follow-up study.

3.7.2 One-Sample Proportion Test of Overall Perceived Socio-Economic Impact (H01)
To test H01, the mean respondent agreement across the four socio-economic impact indicators in Section 3.9 (64%, 62%, 60% and 68%; mean $\hat{p} = 0.635$) was compared against a null benchmark of $p_0 = 0.50$ (i.e., no clear majority perceiving impact), using a one-sample z-test for a proportion with n = 50.

Table 12. One-sample z-test of overall perceived socio-economic impact against a null of no-majority impact ($p_0 = 0.50$).

$\hat{p}$ (mean agreement)	n	z	p-value	Decision at $\alpha = 0.05$
0.635	50	1.91	0.056	Fail to reject H01 (marginal)

The result ($z = 1.91$, $p = 0.056$) narrowly fails to reach conventional statistical significance at $\alpha = 0.05$, though it approaches it. As with the independence test above, this is consistent with an under-powered sample rather than an absence of true effect: the descriptive pattern of majority agreement (60–68%) across all four impact indicators is suggestive of a real socio-economic burden, but a confirmatory test with a sample size meeting the Section 2.5 requirement ($n \geq 399$) is needed before this can be stated with statistical confidence.

3.8 Perceived Causes of Congestion
Respondents attributed congestion along the corridor to a combination of land-use, behavioural and infrastructural factors (Table 13, Figure 9). Uncontrolled establishment of commercial infrastructure such as shopping complexes, filling stations and pharmacies recorded the highest agreement (86%), followed by the location of car parks and tricycle/motorcycle parking lots (84%), roadside/double parking (78%), population increase in Apete and its environs (74%), and pavement potholes (72%). Traffic accidents recorded the lowest agreement (28%) as a contributing cause, suggesting that congestion on this corridor is chiefly structural and land-use driven rather than incident-driven — consistent with the point-specific junction friction identified in Sections 3.3 and 3.4 rather than a generalised link-capacity deficit.

Table 13. Respondent agreement with proposed causes of traffic congestion (n = 50).

Proposed Cause	Agree (%)	Disagree (%)	Undecided (%)
Traffic wardens	62	32	6
Accidents	28	68	4
Population increase in Apete and environs	74	24	2
Road-side hawking	38	44	18
Vehicle breakdown	56	38	6
Road-side / double parking	78	20	2
Inadequate road capacity	62	12	6
Absence of walkways	68	28	4
Potholes	72	28	0
Commercial infrastructure establishment	86	12	2
Car park / tricycle-motorcycle parking lot location	84	14	2

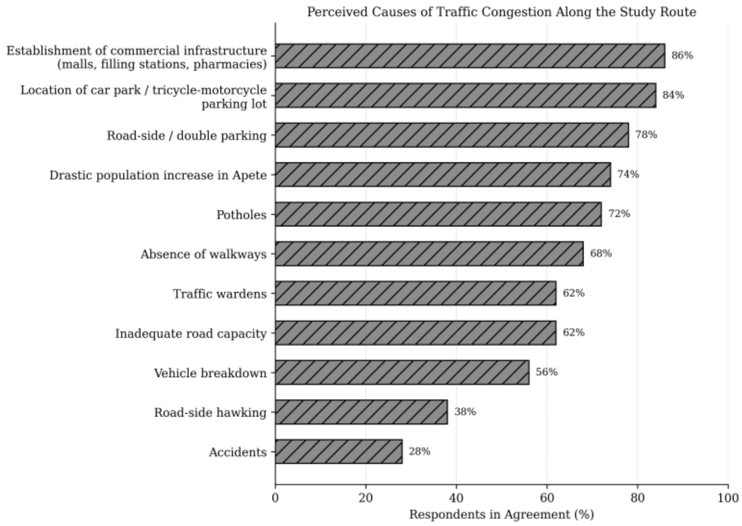

Figure 9. Perceived causes of traffic congestion along the Apete–Fanawole corridor, ranked by percentage agreement.

3.9 Perceived Socio-Economic Impacts

The socio-economic consequences of congestion identified by respondents were dominated by unpredictable travel time (68% agreement), extra fuel consumption (64%), missed or late appointments (62%) and stress/anger (60%) (Table 14, Figure 10; tested jointly in Section 3.7.2). In managing these delays, the largest share of respondents (46%) reported simply managing their own route/lane without crossing into other lanes, while only 12% had lodged a formal complaint with a government agency (Table 15).

Table 14. Perceived socio-economic impacts of traffic delay (n = 50).

Impact	Agree (%)	Disagree (%)	Undecided (%)
Extra fuel consumption (economic)	64	32	4
Late/missed appointment (social)	62	34	4
Stress/anger (social)	60	24	16
Unpredictable travel time (social)	68	28	4

Table 15. Individual coping responses to traffic delay (n = 50).

Response	Frequency	Percentage (%)
Managing own way/route	23	46
Directing traffic individually	7	14
Complaint to government agency	6	12
None of the above	4	8

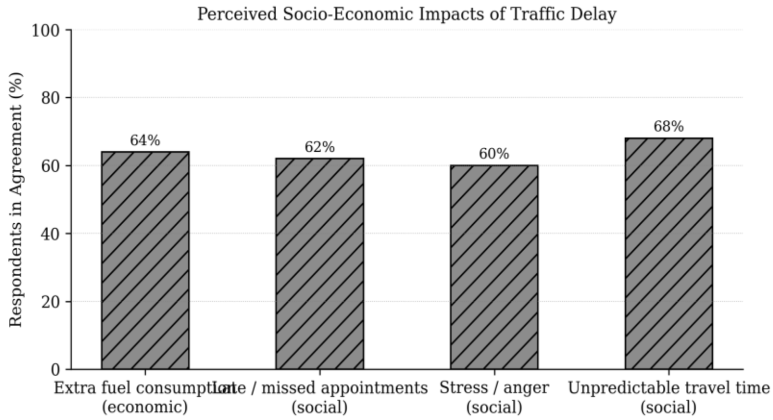

Figure 10. Perceived socio-economic impacts of traffic delay along the study corridor.

IV. Discussion

The PCU-based traffic-flow analysis (Section 3.3) indicates that, under the stated capacity assumptions, the Apete–Fanawole corridor's mid-block carriageway retains substantial reserve capacity, operating at LOS A for ten of the twelve observed sessions and no worse than LOS B in the remaining two. This is consistent with broader Ibadan-wide evidence that vehicular volumes have historically outstripped available carriageway capacity on some arterial and local roads (NURTW/RTEAN, Oyo State, 2001; Ogunsesan and Akanmu, 2010), but the corridor examined here has not yet reached the same degree of link-level saturation reported for Ibadan's historic core. The dominance of motorcycles, tricycles and commercial cars over private cars in the vehicle mix mirrors patterns reported elsewhere in Nigeria's peri-urban and informally serviced transport corridors (Irunokhai and Adigun, 2019), and reflects Apete's function as a public-transport-dependent, student- and trader-oriented settlement rather than a car-owning residential suburb.

This favourable link-level LOS finding stands in marked contrast to the severity of delay reported by respondents — up to 30 minutes or more, on 40% and 20% of occasions respectively (Table 9). Reconciling these two findings is, in itself, a substantive result: because the acceptable mid-block V/C ratios (0.40–0.68) cannot alone explain reported delays of this magnitude, the congestion experienced along this corridor is best explained as point-specific friction concentrated at the Iyana-Fanawole and Fanawole T-junctions — uncontrolled turning movements, roadside/double parking, hawking, and market spill-over (Plates I, IV and V) — rather than as a distributed, corridor-wide capacity deficit. This interpretation is corroborated directly by the questionnaire data: the three highest-ranked perceived causes of congestion (commercial infrastructure siting, 86%; car-park/parking-lot location, 84%; roadside/double parking, 78%) are all point-specific, junction-adjacent land-use factors, while accidents — which would be expected to correlate with poor link-level geometry — received the lowest agreement (28%). The corridor's congestion profile therefore differs qualitatively from the faulty-intersection-geometry and interchange-bottleneck narrative documented for central Ibadan black-spots such as Iwo-Road and Mokola (Popoola et al., 2013), and instead matches the peri-urban land-use-encroachment process described by Adedayo and Akinremi (2015) and Briggs (1991), in which rapid, uncoordinated conversion of farmland and residential plots to commercial use outpaces the provision of parking, walkways and drainage infrastructure.

The Monday peak and the 07:30–09:00 am / 06:00–07:30 pm congestion windows identified by respondents align with standard commuter-driven congestion cycles documented elsewhere for Ibadan's traffic network (Ogunsesan and Akanmu, 2010), reinforcing that the corridor's congestion, although peripheral in location, follows a broadly similar temporal logic to commuting-driven congestion in the city centre. However, the formal Chi-square test of independence between day of congestion and delay duration did not reach statistical significance ($\chi^2 = 3.79$, df = 6, $p = 0.70$; Section 3.7.1), so this apparent Monday-delay association should be regarded as a descriptive trend rather than a confirmed statistical relationship at the present sample size.

The socio-economic impacts reported — unpredictable travel time, extra fuel consumption, stress and missed appointments — correspond to the economic and health consequences of congestion described elsewhere for Nigerian and East African contexts (Awosusi and Akindutire, 2010; Titus and Musa, 2018). The one-sample proportion test of overall perceived impact ($z = 1.91$, $p = 0.056$; Section 3.7.2) narrowly missed conventional significance, again consistent with an under-powered sample rather than a demonstrated absence of impact; the descriptive pattern of 60–68% agreement across all four impact indicators is suggestive of a genuine, shared burden across the sampled population, but should be confirmed with a larger sample before being treated as conclusive. The predominance of individual coping strategies (46% simply managing their own route) over formal complaint mechanisms (12%) further suggests low public confidence in institutional responsiveness, a pattern also reported for the neglected Apete–Awotan road corridor more broadly.

4.1 Limitations

This study has several limitations that qualify the strength of its conclusions. First, and most significantly, the questionnaire sample ($n = 50$) falls far short of the $n \geq 399$ indicated as necessary by Yamane's formula for the Apete population at a 5% margin of error; all percentages and the two inferential tests reported in Section 3.7 should therefore be read as preliminary/exploratory indicators rather than statistically generalisable findings, and this paper is presented accordingly as a pilot study. Second, the practical capacity used to compute V/C ratios and LOS (Section 2.6) rests on a reasoned but unmeasured assumption about carriageway width and on adjustment factors (lane width, side friction, pavement/obstruction) drawn from photographic and field-note evidence rather than from direct instrumented measurement; the LOS classifications in Section 3.3 should therefore be treated as indicative rather than definitive. Third, manual traffic counting, while adequate for the defined peak windows, cannot capture continuous 24-hour or seasonal (e.g., rainy-season) variation in traffic volume; automated tube or video-based counters would improve precision and allow longer observation periods. Fourth, the traverse survey relied on tape-and-GPS measurement rather than higher-precision instruments (e.g., total station or RTK-GPS), which is adequate for route characterisation but not for detailed geometric design, and did not capture cross-sectional (width) data, necessitating the capacity assumptions noted above. Finally, the cross-sectional design captures a single snapshot in time and cannot establish causal or before-after relationships between specific interventions and congestion outcomes.

V. **Conclusion and Recommendations**

This preliminary exploratory study characterised traffic flow and assessed the perceived socio-economic impacts of road traffic congestion along the Apete–Fanawole Junction corridor, Ido Local Government Area, Ibadan, using traverse surveying, manual traffic counting converted to passenger car units, and structured questionnaire administration. Converting raw counts to PCU and estimating volume-to-capacity ratios showed that the corridor's mid-block carriageway operates predominantly at an acceptable Level of Service (A, occasionally B) under the stated capacity assumptions, even during nominal peak periods. This finding, considered alongside the severe delays and point-specific causes reported by respondents — principally uncontrolled commercial infrastructure siting, car-park/parking-lot placement, and roadside/double parking, concentrated at the Iyana-Fanawole and Fanawole T-junctions — indicates that congestion on this corridor is a localised, junction-level and land-use-management problem rather than a corridor-wide capacity deficit. The formal statistical tests conducted (Sections 3.7.1 and 3.7.2) did not reach significance at $\alpha = 0.05$, narrowly in the case of overall perceived impact ($p = 0.056$); given that the achieved sample ($n = 50$) was substantially below the $n \geq 399$ indicated by Yamane's formula, these results should be read as suggestive rather than confirmatory, pending a larger follow-up study.

Because the congestion identified is predominantly junction-level and land-use-driven rather than a link-capacity deficit, and because photographic evidence (Plates I and IV) shows commercial structures and market stalls sited with little to no visible setback from the existing carriageway edge at the Iyana-Fanawole T-Junction and Apete Market, conventional carriageway widening within the current right-of-way would likely require demolition or compensation of existing roadside structures at these specific points. Blanket widening is therefore not recommended as a first-line intervention. Instead, the following context-specific, priority-ordered interventions are recommended, grounded in the corridor's measured 630.15 m geometry and the point-specific friction locations identified in Sections 3.3 and 3.4:

(i) Geometric channelization of the Iyana-Fanawole T-Junction approach within the existing carriageway width, using painted channelizing lines, raised kerb islands or bollards to separate through movements on the Apete Bridge–Fanawole through-route from turning movements onto the Ayegun/Awotan and Sango/Polytechnic legs, without requiring additional land take; (ii) relocation of informal motor-park and tricycle/motorcycle parking nodes currently sited at the junction approaches and at Apete Market (Plates I, IV and V) to purpose-built off-corridor parking areas, since these — not link capacity — were identified by 84% of respondents as a primary congestion cause; (iii) enforcement of a statutory minimum clear/no-parking zone (e.g., 15–20 m of stopping-sight-distance) on the immediate approaches to the Iyana-Fanawole and Fanawole T-junctions, using kerb build-outs or bollards to physically prevent roadside/double parking (identified by 78% of respondents); (iv) enforcement of building setback standards for any new commercial development along the corridor (filling stations, pharmacies, shopping complexes; identified by 86% of respondents), to prevent further encroachment before any future widening becomes feasible; (v) rehabilitation of pothole-damaged pavement sections (identified by 72% of respondents) and improvement of roadside drainage to prevent recurrent deterioration; and (vi) provision of a dedicated pedestrian walkway or delineated shoulder around Apete Market, where the majority of daytime and evening conflict was observed (Plates IV and V).

Future research should prioritise, first, a confirmatory follow-up survey with a sample size meeting or exceeding the $n \geq 399$ threshold established in Section 2.5, allowing the Chi-square and proportion tests reported here to be repeated with adequate statistical power; second, direct instrumented measurement of carriageway cross-sectional width and automated, multi-season traffic counts to replace the capacity assumptions used in Section 2.6; and third, a before-after evaluation once junction channelization or parking relocation is implemented, to quantify the operational and socio-economic returns of the recommended interventions.

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