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Road Space Users' Perception and Analysis of Road Traffic Conflicts in Bauchi Central Business District, Bauchi State, Nigeria

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Abstract
Road traffic conflicts are a major but neglected global transport challenge which is influenced by the risky driving behaviour or other attitudes of road space users such as pedestrians, cyclists, motorists and others. Conflicts in the use of motor vehicles on road transportation are inevitable even when traffic conflict mitigating facilities such as speed humps, traffic signs and others are provided. Development triggers transportation and vice versa. Without a corresponding increase in traffic conflict mitigating facilities or strategies to increase capacity for coping with increased traffic volume, the resultant effect is an increase in auto crashes and fatalities. In order for planners to respond efficiently and effectively to traffic conflict issues in neighbourhoods, business districts and regions, there is a need to incorporate the views of motorist, cyclists, pedestrians and others who are the road space users. The study adopted a survey-based approach and sampled 120 road space users consisting of 55 motorcyclists, 30 motorists, 20 tricycle operators and 15 pedestrians. The study discovered that the promotion of publicly-owned public transport is the major strategy recommended for reducing traffic conflicts in Bauchi Central Business District.
Keywords: Traffic conflict, Road space, Public transport operators, Pedestrians, Planning

1.0 Introduction

Road space users' refers to the array of human operators who walk, drive, ride or patronise cars, motorcycles, tricycles and others. A *traffic conflict* is a *traffic* event involving the interaction of two or more road users' usually motor vehicles, where one or both drivers take evasive action such as braking or swerving to avoid a collision (Parker Jr *et al.*, 1989). Traffic conflict studies according to (Shelby, 2011), "have historically been conducted with a team of observers trained to identify and characterize the severity of narrowly-averted traffic collisions as they watch traffic from the roadside" (p. 1). Motor vehicles, non-motors, and pedestrians will cause mutual restriction when they go straight or turn at uncontrolled intersection (Sun & Lu, 2011). The commonness of traffic conflicts between pedestrians and vehicles will increase, especially when the intersection or junctions have heavy traffic and serious mixed vehicles such as lorries, trucks, motorcycles, buses, tricycles and others (Sun & Lu, 2011). In the words of Chater *et al*. (2018, p. 93), "to drive safely among human drivers, cyclists and pedestrians, autonomous vehicles will need to mimic, or ideally improve upon, humanlike driving. Yet, driving presents us with difficult problems of joint action: 'negotiating' with other users over shared road space." There is always a disagreement about which comes first, 'undeveloped lines of movement' or 'means of road transportation' in neighborhoods, business districts and others. The truth is, the prediction of traffic volumes of urban roads and the assessment of alternatives in the case of policy-making for building new infrastructure is preceded by land use patterns according to the urban master plan (Karimi, Ghadirifaraz, & Boushehri, 2018). The aim of this paper is to examine the views of road space users on road traffic conflicts and how these views relate to planning.

2.0 Conceptual and literature review

Perkins and Harris (1967) were among the first researchers to coin the term, "traffic conflict". A traffic conflict is a glaring situation in which two or more road users approach each other in space and time to a degree extent that there is a probability of collision if their movements remain unchanged" (Amundsen & Hyden, 1987). However, "the proximity in time and (or) space provides a quantitative way to distinguish conflicts and non-conflict events" (Zheng *et al*., 2014, p.635). "An important reason to use traffic conflicts as complementary of collision is that conflicts occur more frequently than collision (Zheng *et al*., 2014). Thus, "A traffic conflict point is the intersecting point between different traffic movement paths. Traffic conflict points can be grouped into crossing, merging and diverging types. Based on such a definition, a conflict point needs to meet the following conditions: (1) there are different traffic flows moving towards different directions, (2) these different traffic flows intersect at the same time, and (3) these different traffic flows intersect at the same location" (Lu *et al*., 2011, p.4). Hence, the general consensus of what a road traffic conflict point is a spot of inconvenient maneuver by road users (which usually occurs at intersections and junctions) due to the poor street plan/design

considerations and/or the lack of traffic control facilities at such intersections/junctions.

Traffic conflicts can be detected from real traffic situation or predictable from simulated traffic situation. Traffic management encompasses the array of control facilities and personnel for the control of traffic in a metropolis. Thus, the effectiveness of road transportation relies heavily on several factors such as traffic count and conflict data and the attitude of the road driver to traffic engineering, control and management requirement" *(Oyadiran & Aregbesola,* 2008). There are different methods of collecting traffic conflict data such as field observation (Zheng *et al*., 2014), video system method (Ismail *et al*., 2009) and the "naturalistic driving studies, in which, participating vehicles are equipped with advanced data acquisition system including cameras and various sensors, which continuously and inconspicuously register vehicle maneuvers, drivers' behaviour and external conditions for several months and years" (Zheng *et al*., 2014).Traffic conflict management can only be feasible when road users' perceptual knowledge and traffic conflict data are mirrored in the overall process of controlling traffic flow.

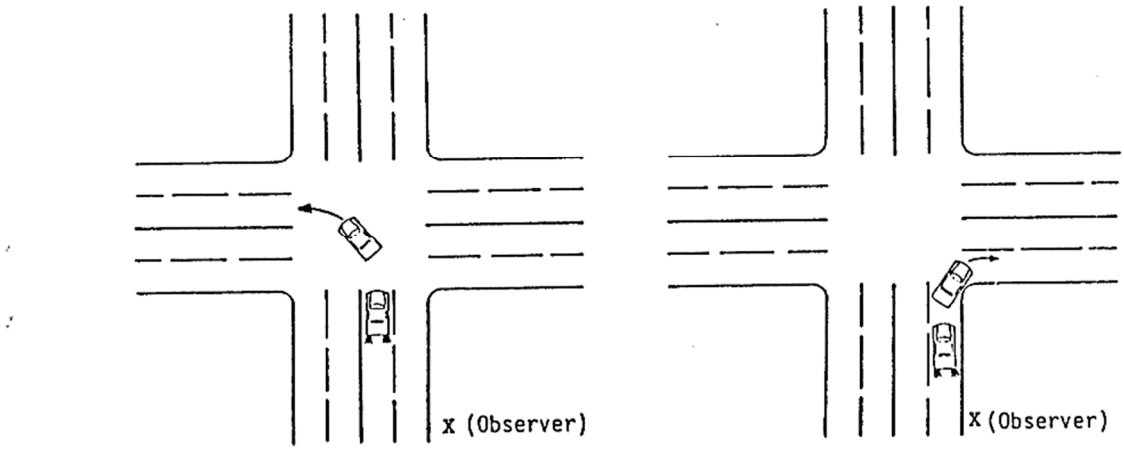


Figure 1. Left-turn, same direction conflict and right-turn, same direction conflict primary conflict
Source: Parker & Zegeer (1989)

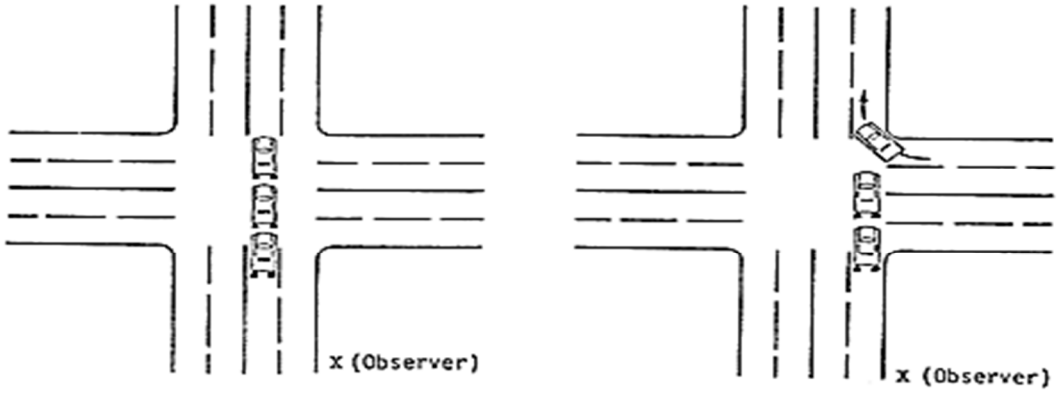


Figure 2. Slow-vehicle, same direction secondary conflict and Right-turn, cross-traffic-from-right secondary conflict.
Source: Parker & Zegeer (1989)

According to Parker & Zegeer (1989), road traffic conflicts can be classified into three; vehicular and cyclist traffic conflict, pedestrian conflict and other traffic conflict events. Consequently, these classifications can either be grouped into primary or secondary conflicts. A primary conflict occurs as a result of an evasive maneuver by a second road user (vehicle, motorcycle, tricycle or other automobiles) to avoid a conflict situation posed by the first road user (see Figure 1). A secondary traffic conflict is an event that involves at least three (3) vehicles (road users). In this case, the second road user may place a third road user in a traffic collision situation while trying to maneuver his way from a conflict situation posed by the first road user (see Figure 2). Pedestrian road traffic conflict occurs when a pedestrian (road user causing conflict) crosses in front of a vehicle that has the right of way, thus creating a possible collision situation (see Figure 3).

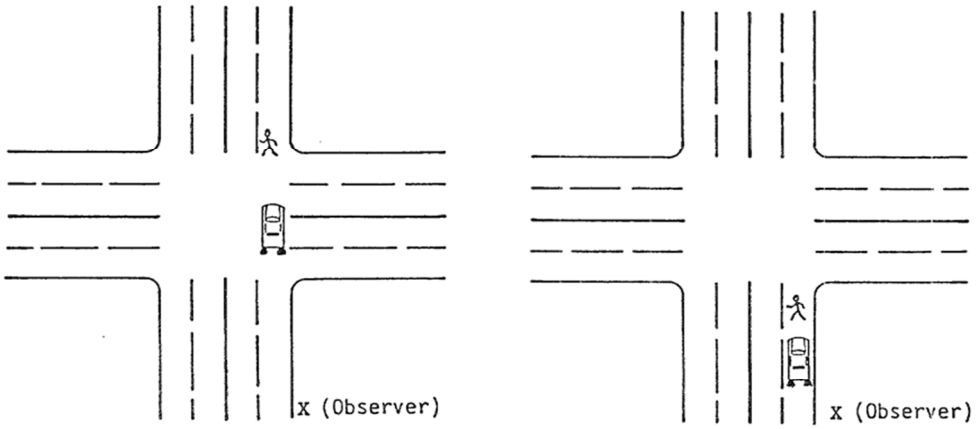


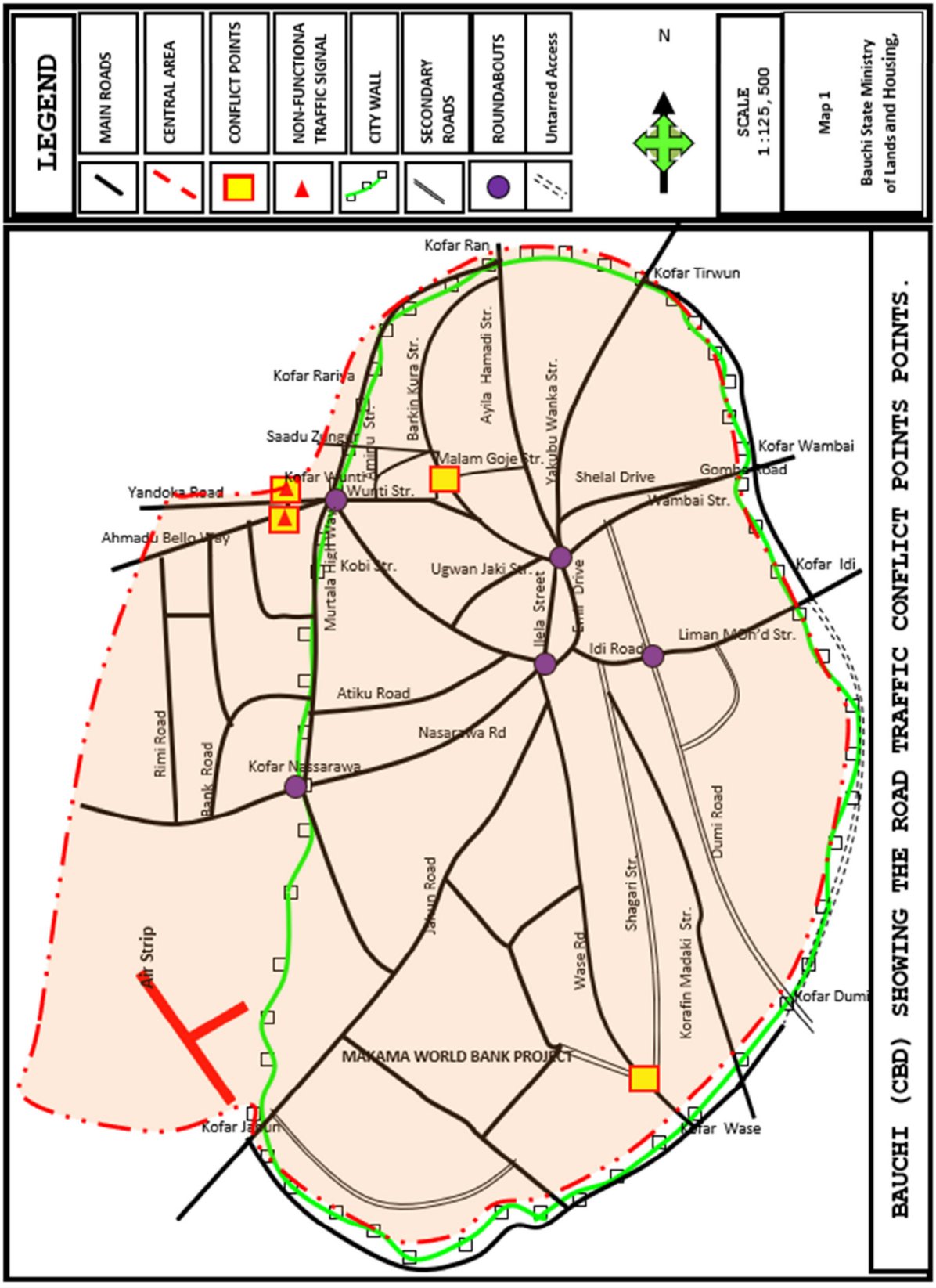
Figure 3. Pedestrian, far-side conflict and Pedestrian, near-side conflict
Source: Parker & Zegeer (1989)

3.0 Study Area and Methodology

Bauchi is a city in Northeast Nigeria (see Map 2), and the capital of Bauchi State is situated in Bauchi Local Government Area (see Figure 3). Its geographical coordinates are Latitude 10^0 18' 57'' North and Longitude 9^0 50' 39'' East. Bauchi has an altitude of 690.2m above sea level with an annual rainfall of 1091.4mm. The hottest and coldest temperatures are noticeable in the months of April and (December, January), 40.56^0c and (6.11^0c and 7.22^0c) respectively. Bauchi Local Government Area is bordered in the North, West, East, Southwest and Southeast by Ganjuwa, Toro, Kirfi, Tafawa-Balewa and Alkaleri respectively.

The Central Business District (CBD) in Bauchi is the hub of most economic, social, institutional and religious activities. It is located in Bauchi Local Government. It houses the major banks, office complexes, markets such as Wunti Market, Muda Lawal Market, Central Markets, religious worship centres such as the Central Mosque and others. Thus, the Central Business District (CBD) generates and attracts traffic.

The perception of a sample of 55 motorcyclists, 30 motorists, 20 tricycle operators and 15 pedestrians were surveyed for this study between 8am and 6pm for three days (Tuesdays, Thursdays and Saturdays) on 20th April, 2018. The authors and two other trained field survey assistants conducted the survey by patronising privately-owned public transport operators (tricycle operators, motorcyclists and motorists) moving out or into the Bauchi Central Business District. This was achieved by paying transportation fare to the Central Business District and within the journey time, the survey was conducted. Survey for the ten pedestrians who alighted from a privately-owned public transport vehicle, motorcycle or tricycle was conducted randomly at undesignated bus stops within the CBD. Prior to the questionnaire administration, the road space users' were asked if they had a near-crash experience and how long they have patronised such intersections to ascertain their capacity to respond appropriately. Hausa, Pidgin and English were the languages used for the administration of the questionnaire as a strategy to ridicule the language barrier effect.


LEGEND
MAIN ROADS
CENTRAL AREA
CONFLICT POINTS
NON-FUNCTIONA TRAFFIC SIGNAL
CITY WALL
SECONDARY ROADS
ROUNDABOUTS
Untarred Access
N
SCALE 1:125,500
Map 1
Bauchi State Ministry of Lands and Housing,
BAUCHI (CBD) SHOWING THE ROAD TRAFFIC CONFLICT POINTS.
Kofar Ran
Kofar Tirwun
Kofar Rariya
Barkin Kura Str.
Ayila Hamadi Str.
Yakubu Wanka Str.
Saadu Zungur
Malam Goje Str.
Kofar Wambai
Shelal Drive
Gombe Road
Wambai Str.
Yandoka Road
Kofar Wunti
Wunti Str.
Ahmadu Bello Way
Murtala Highway
Kobi Str.
Ugwan Jaki Str.
Ilela Street
Kofar Idi
Liman Moh'd Str.
Idi Road
Atiku Road
Nasarawa Rd
Rimi Road
Bank Road
Kofar Nassarawa
Jahun Road
Shagari Str.
Dumi Road
Wase Rd
Korafin Madaki Str.
Kofar Dumi
Air Strip
MAIAMA WORLD BANK PROJECT
Kofar Jahuri
Kofar Wase

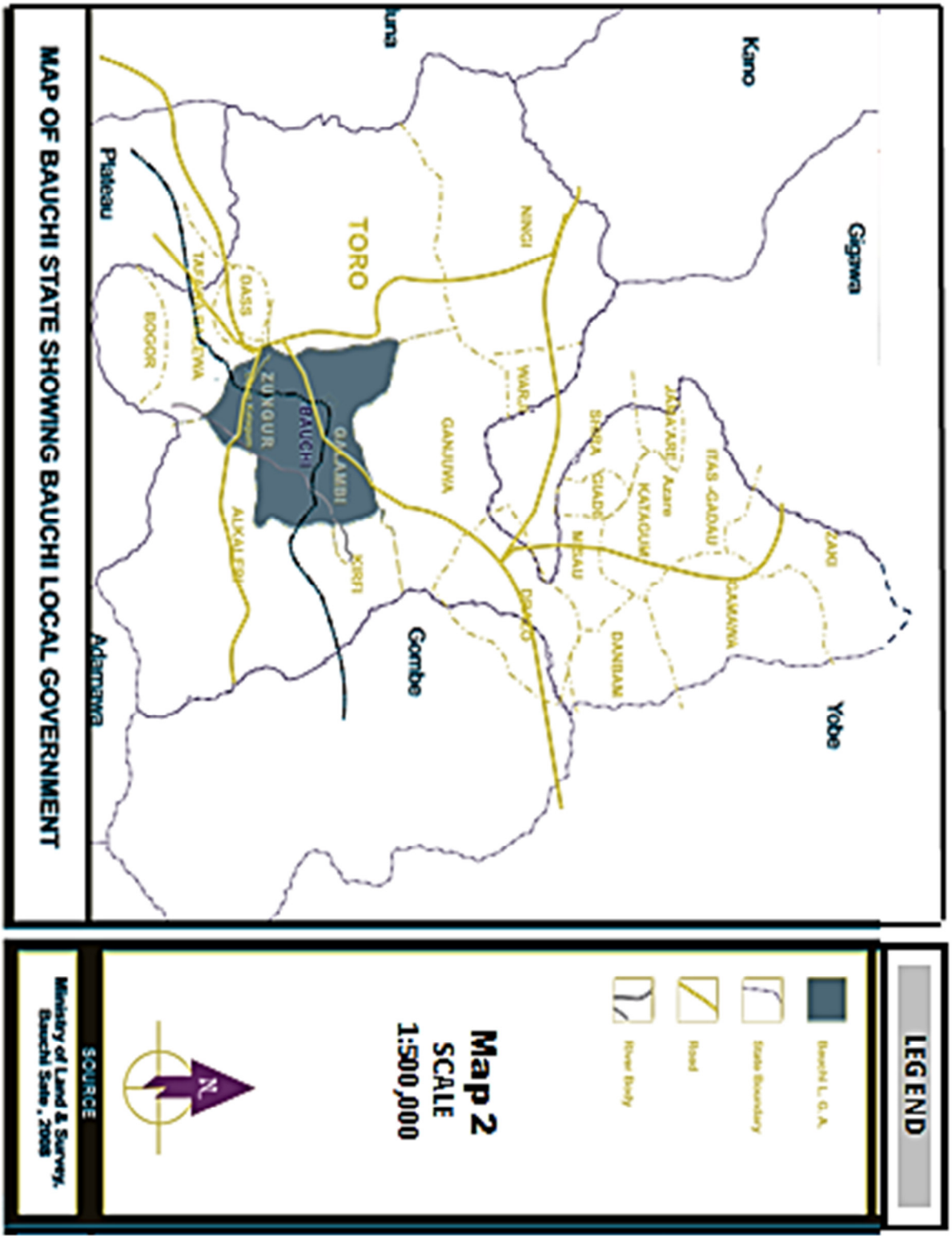


Table 1. Selected intersections/junctions of conflict and number of respondents

S/No	Name of intersection/junction	Number of respondents
1	Ahmadu Bello-Murtala Way-Wunti	41
2	Yandoka-Murtala Way-Wunti	39
3	Barkin Kura-Mallam Goje	25
4	Wase Road-Shagari Junction-Off Muri Guest Inn	15
	Total	120

Source: Author's field survey, 2018; Map 1.

Gender distribution of respondents as shown in Table 2 indicates that 75.8% and 24.2% are males and females respectively. The level of respondents' education shows that 27.5%, 35.0%, 20.8%, 14.2% and 2.5% have no education, basic education, high school education, tertiary education and other forms of education. The marital status of respondents revealed that, 19.2%, 10.0%, 4.2%, 20.8%, 42.5% are divorced, widowed, separated, single and married. The ethnic background of respondents revealed that 67.5%, 19.2%, 5.0% and 8.3% are Hausa/Fulanis, Igbo, Yoruba and from other ethnic groups. Respondents' religion reveals that majority are of the Islamic faith accounting for 62.5%, Christians are 33.3% and traditional worshippers are 4.2%. The monthly income distribution among respondents presented in Table 2 showed that 18.3%, 27.5%, 41.7%, 7.5% and 5.0% earn between 1000 – 15,000 naira, 16,000 – 30,000 naira, 31,000 – 45,000 naira, 46,000 – 60,000 naira and above 60,000 naira only. Kumar (2013) in a study on the socio-demographic profile of road traffic accidents victims observed the middle and high class road space users who have medium and high income earning capacity had the propensity to make more home and non-home based trips , thus more prone to road traffic conflicts. He further noted that males drive automobiles than females even though females make more chained trips than males. Consequently, Kumar (2013) noted that males have the propensity to experience road traffic conflicts than females.

Table 2. Distribution of road space users' gender, educational level, marital status, ethnicity and religion

Variables	Categories	Frequency	Percentage
Gender	Male	91	75.8
	Female	29	24.2
	Total	120	100
Educational level	No education	33	27.5
	Basic education	42	35.0
	High school education	25	20.8
	Tertiary education	17	14.2
	Others	3	2.5
	Total	120	100
Marital status	Divorced	23	19.2
	Widow/widower	12	10.0
	Separated	5	4.2
	Single	25	20.8
	Married	51	42.5
	Others	4	3.3
	Total	120	100
Ethnicity	Hausa/Fulani	81	67.5
	Igbo	23	19.2
	Yoruba	6	5.0
	Others	10	8.3
	Total	120	100
Religion	Christian	40	33.3
	Islamic	75	62.5
	Traditional	5	4.2
	Total	120	100
Income (₦000)	1 – 15	22	18.3
	16 – 30	33	27.5
	31 - 45	50	41.7
	46 – 60	9	7.5
	60 and above	6	5.0
	Total	120	100

Source: Authors' field survey, 2018

Out of 120 respondents, 91(87%) affirmed they have witnessed a road traffic conflict while 11(10%) and 3 (3%) (see Figure 3).

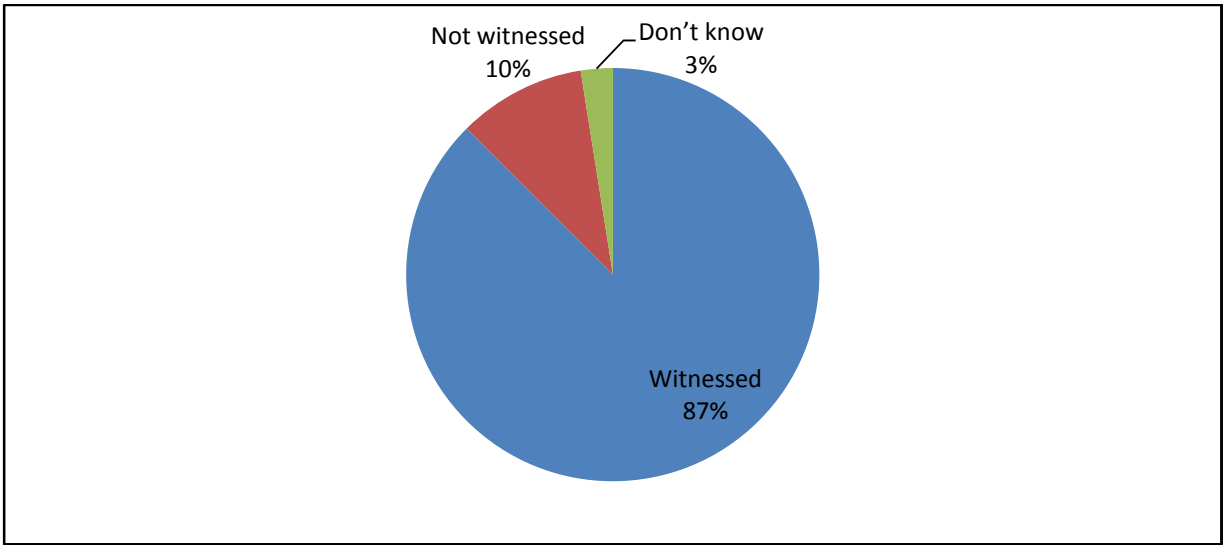


Figure 3: Experience of a Road Traffic Conflict
Source: Authors' field survey, 2018

Violation of right of way is the major cause of road traffic conflicts according to the respondents (see Table 3). Excessive or poorly adapted speed accounted for 7.6%, road user's inexperience accounted for 10.5 percent of the causes of road traffic conflicts by the respondents while wrong interpretation of traffic road signs, too-small-a-distance to the preceding car and other risky driving behaviour accounted for 1.9%, 2.9% and 1.0% respectively. These deduction correlates with the findings of Uno *et al.* (2002); Uzondu *et al.* (2018) which noted the influence of human errors and unsafe driving behaviour on increased cases of traffic conflicts. Berg (2006) and McCartt *et al.* (2009) also observed that lack of driver's experience and the careless attitudes of zealous age groups such as the youth is a major cause of road traffic conflicts.

Table 3. Cause of the road traffic conflict

Causes	Frequency	Percentage
Wrong interpretation of traffic sign	2	1.9
Road user's inexperience	11	10.5
Violation of right of way	80	76.2
Excessive or poorly adapted speed	8	7.6
Too small a distance to the preceding car	3	2.9
Other risky behaviour (specify)	1	1.0

Source: Authors' field survey, 2018

The promotion of publicly-owned public transport is the major strategy suggested by respondents to reduce road traffic conflicts (see Table 4). Other strategies recommended include regular traffic studies by planners (25.0%), traffic education by road safety agencies and units (20.8%), introduction of underpasses (footbridges) to reduce pedestrian conflicts (10.8%), liaison with security agencies by planners (7.5%) and others. Transport (2004) suggested in a study, that dedicates spaces for cycling and pedestrians away from general traffic such as pedestrian priority at junctions will prevent or reduce the cases of road traffic conflict. Garber *et al.* (2014) noted that the promotion of publicly-owned public transport and the introduction of some pedestrian infrastructure such as foot bridges and other traffic calming facilities such as speed humps is a strategy for reducing road traffic conflict.

Table 4. Strategies for the reduction of traffic conflicts

Strategies	Frequency	Percentage
Traffic education	25	20.8
Regular traffic studies by planners	30	25.0
Liaison with security agencies by planners	9	7.5
Promotion of publicly-owned public transport	41	34.2
Introduction of under passes and traffic calming facilitie	13	10.8
Others (specify)	2	1.7
Total	120	100

Source: Authors' field survey, 2018

Motorcycles and cars are the major mode of transportation in the study area accounting for 35.8% and 33.3% of the responses, while tricycles, buses, human-powered public transport and animal-powered transport accounted for 20.8%, 1.7%, 5.0% and 3.3% (see Table 5). Nguyen *et al.* 2014 also affirmed that there is a

relation between non-lane-based movements and traffic conflict events. Nguyen *et al.* (2014), observed that motorcycles is more preferred as a mode of transport in third world countries such as India and "traffic conflict under congested conditions is one of the main safety issues of motorcycle traffic in developing countries. Unlike cars, motorcycles often display non-lane-based movements such as swerving or oblique following of a lead vehicle when traffic becomes congested" (p. 137).

Table 5. Preference of transit mode

Preference	Frequency	Percentage
Bus	2	1.7
Tricycle	25	20.8
Motorcycle	43	35.8
Car	40	33.3
Human-powered public transport	6	5.0
Animal-powered public transport	4	3.3
Total	120	100

Source: Authors' field survey, 2018

The opinions of respondents on whether privately-owned public transport have being fully integrated into space planning within the Central Business District, shows that 70.0% of respondents are not aware of any coordination, while 12.5%, 8.3%, 5.8% and 15.0% are mostly coordinated, about half are coordinated and fairly coordinated (Table 6).

Table 6. Level of coordination of privately-owned public transport with developments in CBD

Coordination	Frequency	Percentage
All developments within CBD are coordinated	15	12.5
Most are coordinated	10	8.3
About half are coordinated	7	5.8
Fairly coordinated	18	15.0
None are coordinated	70	58.3
Total	120	100

Source: Authors' field survey, 2018

4.0 Conclusion and Recommendation

Road traffic conflicts are caused by inappropriate street plans/design, traffic congestion, risky driving behaviour and modal composition in a single travel. A road traffic conflict impedes traffic flow, reduces traffic safety and creates noise pollution. The perception of road space users is necessary if traffic conflict cases are to be minimised. A road traffic conflict study is a reactive research to reduce traffic problem and it is important that whatever is to be suggested for reducing or managing the conflicts must be timely as lives may be lost in seconds.

5.0 Acknowledgements

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