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Understanding the Factors Influencing Pedestrian Crossing Behavior and its Effect on Road Performance in Port Harcourt City

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Understanding the Factors Influencing Pedestrian Crossing Behavior and its Effect on Road Performance in Port Harcourt City

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Abstract- In Port Harcourt city, the design of roads do not adequately accommodate pedestrians, leading to ongoing conflicts as motorists and pedestrians try to share the limited spaces on roads. However response time to control vehicles in Port Harcourt is minimal making pedestrian crossing behavior at intersections and midblock crossings significantly more complicated. These problems created the need for additional research into pedestrian crossing behavior at crucial roads in Port Harcourt. This study's primary goal is to discover the factors influencing pedestrian crossing behavior at signalized intersections and midblock crossings and its effect regarding road performance. Considering this reason, 520 questionnaires were developed and shared among road users (drivers and pedestrians) to determine the factors influencing pedestrian crossing behavior. Again, traffic survey was conducted using a camcorder, questionnaires were analyzed using the Likert scale to identify elements that may be critical. In addition, the level of service (LOS) was used to assess the effect on congestion. This study revealed that age, lack of crossing facilities, location of crossing facility, lack of educational awareness which had a mean value between 3.5-5.0 are considered critical factors influencing pedestrian crossing attitude. Gender with a mean value at 2.304 is not a critical factor, while the use of mobile phone which had a 2.626 mean value is a neutral factor. The volume to capacity ratio (V/C) value of the road segments ranging from 0.72 to 0.97 is shown by the LOS which means smooth to low traffic flow with an affected speed and high vehicular density. It is a true reflection of the roads in Port Harcourt. It was observed that at major roads with signalized intersection that 73.19% of pedestrians conform to signal indications at peak hours.

Keywords: pedestrian crossing behavior, congestion, signalized intersection, midblock crossing.

I. Introduction

Vehicles have traditionally been the focus of traffic research on roads in developing countries. In constructing roads, considerations for pedestrian comfort, convenience, and safety are usually not given priority in Nigeria. Some difficulties experienced are modeling of pedestrian behavior in Nigeria. So many complications are involved in trying to identify the characteristics that influence pedestrian behavior. For densely populated cities like Port Harcourt, pedestrian traffic at unsignalized crossroads, signalized crossroads and midblock crossings are very common with little or no provision for safe pedestrian crossing. For some intersections crosswalks where people and cars share the same road area, signal phases have been provided to regulate this interaction in Port Harcourt, collisions between pedestrians and vehicles still happen as a result of pedestrian disobedience with traffic signals. However, pedestrian non-conformance with traffic signals causes pedestrian-vehicle interactions. Poor-quality traffic management, high traffic volume, and extended cycle times (waiting time) are some of the causes of pedestrian non-conformance with traffic signals. There are numerous other variables that influence how pedestrians' respond to signals and interactions not included in previous research.

Analyses of pedestrian behaviour have significant consequences for transportation systems, as well as for urban planning principles and methods of design (Laxman et al. 2010). Many research studies according to Laxman *et al.* (2010) have focused on the characteristics of pedestrians and the features of pedestrian movement in sidewalks and walkways only. A hand full of the studies have looked at the pedestrian flow characteristics at signalized crossings in order to develop pedestrian models for evaluating walking facilities. There have been few studies that looked at pedestrian disobedience at signalized crossings in order to develop pedestrian speed flow relationships (Zhou et al. (2011) and delay models (Li et al. (2013); Marisamynathan & Vedagiri (2013)). For the purpose of increasing pedestrian safety at signalized crossings, pedestrian crossing habits were investigated, and factors affecting those behaviors were found (Ren *et al.* 2011).

Numerous characteristics have been overlooked in previous studies on pedestrian crossing behavior which is being found in the aforementioned investigations. A study that considers effective elements like pedestrian features, behavior, and traffic characteristics has not yet been done to analyze pedestrian crossing speed variation and pedestrian-vehicle interaction in crosswalks of signalized crossings. Here in Nigeria, studies of this kind are lacking. Thus, this study seeks to identify the factors influencing pedestrian crossing behaviors in Port Harcourt through a structured questionnaire method.

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According to the WHO (2013), 22% of all fatalities which results from traffic accidents involve pedestrians, with more than 270,000 fatalities annually. According to Naci *et al.* (2009) and ACI-ISTAT (2013), pedestrians hit by motor vehicles account for the most significant percentage of road user fatalities, while the majority of injuries take place in urban areas (Bella & Ferrante 2021). For a variety of reasons, a pedestrian might cross the street; some might be hurried and disobey the rules, which occasionally lead to traffic jams and accidents on the road. Drivers must moderate their speed to prevent accidents due to pedestrians' frequent road crossing behavior. It is well known that the driver's inability to yield to the pedestrian cause collision between pedestrians and vehicles. Lowering the vehicle's speed improves pedestrian safety. Random pedestrian crossings of the road force drivers to halt often, which congests the traffic. The effects of unrestrained pedestrian movement on road accidents have been discussed by several scholars [Bichicchi et al. (2017); Gitelman et al. (2017); Killi & Vedagiri, (2014)].

Traffic congestion has had significant negative social, economic, and environmental effects of recent. The economic effects of traffic congestion in developing nations have been the subject of numerous academic studies. Otto and Awarri (2022), Otto and Ogboda (2022), and Otto and Simon (2022) all discussed on achieving sustainability in the transportation and traffic engineering industry when discussing road traffic congestion in Port Harcourt city. A thorough analysis of the factors contributing to traffic congestion in Port Harcourt City is still lacking from the body of knowledge. This study is the first of its kind to address pedestrian crossing behavior in the city of Port Harcourt, in-order to better and more thoroughly formulate policies for a sustainable urban transportation system, this study filled a research gap by identifying the variables influencing pedestrian crossing behavior and road user safety along Port Harcourt's major roads. It also evaluated the impact of pedestrian behavior on traffic congestion along East-West Road, Port Harcourt-Aba Expressway, Ikwerri road, Ada George Road and Rumuokwuta-Choba Road since these roads are the most busiest in the city.

II. Materials and Method

a) Materials

Recording sheets, a pencil, a measuring tape, camcorder, and tripods were the materials utilized in this study.

b) Method

In order to ascertain the pedestrian crossing behavior along these major routes, a thorough field survey was conducted. The statistics were gathered utilizing camcorder in various traffic intersections and midblock crossings over various time intervals on weekdays (7am to 9am as the morning peak hour and 5pm to 7pm as the evening peak hour). The camcorder included data on pedestrian crossing frequency, pedestrian appearance (gender and age group), pedestrian crossing behavior (walking or running), pedestrian crossing locations (using the crosswalk or not), pedestrian crossing phase time (whether pedestrians cross during green phase or not), and pedestrian-vehicle interactions in crosswalks. Also, a well-developed questionnaire was distributed to 500 road users (pedestrians) along these major roads (East-West Road, Port Harcourt-Aba Expressway, Ikwerri road, Ada George Road and Rumuokwuta-Choba Road) to ascertain the factors influencing pedestrian crossing behavior. The responses were then analyzed statistically to determine the factors that are critical using the Likert Scale.

Rensis Likert, an American psychologist, developed the Likert scale in 1932. Likert saw that there was a need to measure people's opinions concerning diverse subjects, whereas scholars in the 1930s used closed ended questions and aims to make their research valid. In order to quantify people's thoughts and attitudes, Likert created the Likert scale, a psychometric scale (Sack, 2021). The Likert scale makes the notion that attitudes or views can be measured. The five-point Likert scale, which ranges from strongly disagree to strongly agree, is the one that is most frequently used. Each response receives a score, sometimes known as a number, ranging from 1 to 5 (McLeod, 2019). For example, "Strongly Disagree" may receive a score of 1, "Disagree" could receive a 2, "Neutral/Undecided" could receive a 3, "Agree" could receive a 4, and "Strongly Agree" could receive a 5.

In this study, the Likert scale as stated above was adopted. Respondents responded to the statements/questions by indicating their opinion based on the 5-point Likert scale of strongly disagree to strongly agree. Using the logic that a mean score of 3 on the Likert scale reflects a neutral, a mean score of less than 3 represents a non-critical effect, and a mean score of greater than 3 represents a critical effect was then calculated. The Likert scale mean score has the following interpretation ranges in this study: 1.0-2.4 (not critical), 2.5-3.4 (neutral), and 3.5-5.0 (critical). The mean score was determined using Equation 1.

$$Mean\ Score = \sum f_i\, x \ \div Number\ of\ Respondants \quad 1$$

Also, the level of service (LOS) of these roads was determined to assess the effect of pedestrian crossing behavior at midblock locations. When evaluating a transportation facility from the perspective of a traveler, LOS method is adopted. Due to its simplicity, LOS has become fairly common in practice. The volume to capacity (V/C) ratio, maximum service flow rate, vehicle speed, and other traffic parameters can all be used to determine LOS (Wang *et al* 2018).

The ratio of vehicles passing a point in an hour (V) to the maximum number of vehicles that can pass through that place, has been used in this study. LOS performance is assessed using the V/C ratio. The road segments where traffic mitigation measures are required can be identified by this indicator and made known to transportation operators. There are six service levels listed, and each is assigned a letter designation from A to F (Table 1) (Bhuyan & Nayak 2013). The best operational conditions are indicated by LOS A, and the worst operational conditions are indicated by LOS F. Utilizing information from the traffic volume survey, the average LOS of the road segments have been determined. The LOS of each chosen traffic segment was determined using equation 2 in order to evaluate the effects of pedestrian crossing behavior on traffic flow.

$$LOS = \frac{Volume}{Capacity} \quad 2$$

Table 1: Level of Service Description (Zhou *et al* 1997)

V/C	LOS Class	Traffic State
0 - 0.6	A	Free flow
0.61 - 0.70	B	Stable traffic flow, speed is unaffected
0.71 - 0.80	C	Stable traffic flow, speed is affected
0.81 - 0.90	D	Stable flow with high vehicle density
0.91 - 1.0	E	Low speed
>1.0	F	Breakdown flow

III. Results and Discussions

a) Pedestrian Crossing Statistics at Midblock Crossing

The average pedestrian crossing statistics at midblock crossing observed along the major roads considered in this study are presented in Table 2.

Table 2: Pedestrian Crossing Statistics at Midblock Crossing

Observed Parameters		No. of Observed Pedestrians	Percentage (%)
Gender	Male	422	67
	Female	208	33
Age group	Children	92	14.6
	Adult	452	71.75
	Elderly	86	13.65
Crossing type	Running	432	68.57
	Walking	198	31.43

According to the statistics a total of 630 pedestrians were observed crossing at midblock crossings as shown in Table 2. More men (67%) than women (33%) walk during peak hours, and adult pedestrians make up the largest part (71.75%) as compared to children (14.6%) and the elderly (13.65%). This is in line with a study carried out by Olawole & Olayiwola (2018) and Marisamynathan & Perumal (2014). Also, 68.57% of pedestrians crossing at midblock prefer to run when crossing rather than walk (31.43%). This is because of the lack of crossing facilities which prompts the pedestrians to use the observed vehicle gaps as the safest time to cross. In a study carried out by Marisamynathan & Perumal (2014), 80.26% of pedestrian crossings walk because pedestrian crossing facilities are provided. From observation factors that make pedestrians to run while crossing include lack of crossing facilities, lack of road signs, improper educational awareness of road usage by drivers/pedestrians and behavior of drivers who do not consider pedestrians and other road users while driving. Also, most drivers in Nigeria are inexperienced, unqualified, and do not obey traffic/road rules. This has led to a lot of pedestrian vehicle accident which in most cases are not properly recorded in this part of the world.

b) Pedestrian Crossing Statistics at Signalized Intersections

The average pedestrian crossing statistics of 526 pedestrians at signalized intersection observed along the major roads considered in this study are presented in Table 3.

Table 3: Pedestrian Crossing Behavior at Signalized Intersections

Observed Parameters		No. of Observed Pedestrians	Percentage (%)
Crosswalk Utilization	Yes	334	63.5
	No	192	36.5
Compliance	Conformance with signal phase	385	73.19
	Non-Conformance with signal phase	141	26.81

The crosswalk is only used by 63.5% of pedestrians, according to the research. The 73.19% conformance rate for pedestrians with traffic signals shows that conformance is more common at peak hours in signalized intersections here in Port Harcourt. It is clearly seen that the conformance at signalized intersection is higher in Port Harcourt as compared to Mumbai in India according to Marisamynathan & Perumal (2014).

c) *Factors Influencing Pedestrian Crossing Behavior along Major Roads in Port Harcourt*

The factors influencing pedestrian crossing behavior in Port Harcourt were identified from a questionnaire survey of road users including drivers and pedestrians. This is shown in Table 4. From the survey results, age, gender, lack of crossing facilities, use of mobile phones, location of crossing facility, educational awareness are the major factors responsible for pedestrian crossing behavior. Using the Likert scale to analyze the responses of 500 respondence, age, lack of crossing facilities, location of crossing facility, educational awareness are critical factors while gender is not critical and the use of mobile phone is neutral. This result gives a true reflection of Port Harcourt roads. Major roads in Port Harcourt do not have pedestrian crossing facilities. In some cases where pedestrian crossing facilities are available, they are located at places where crossing is highly minimal. Example of such road is the Port Harcourt-Aba Expressway. In terms of age, older people have a better crossing behavior than young people.

Table 4: Factors Influencing Pedestrian Crossing Behavior Along Major Roads in Port Harcourt

Statement	Strongly Disagree (1)		Disagree (2)		Neutral (3)		Agree (4)		Strongly Agree (5)		Total Score	Mean Score	Remarks
	f	%	f	%	f	%	F	%	f	%			
Do you agree that age Influences Pedestrian crossing behaviour?	30	6	42	8.4	11	2.2	166	33.2	251	50.2	2066	4.132	Critical
Do you agree that gender influences pedestrian crossing behaviour?	145	29	173	34.6	99	19.8	51	10.2	32	6.4	1152	2.304	Not Critical
Do you agree that Lack of crossing facilities influences pedestrians crossing behaviour?	21	4.2	13	2.6	31	6.2	153	30.6	282	56.4	2162	4.324	Critical
Do you agree that the use of mobile phones influences pedestrian crossing behaviour?	121	24.2	106	21.2	161	32.2	63	12.6	49	9.8	1313	2.626	Neutral
Do you agree that the location of crossing facilities influences pedestrian crossing behaviour?	9	1.8	31	6.2	61	12.2	78	15.6	321	64.2	2171	4.342	Critical
Do you agree that education/awareness influences pedestrian crossing behaviour?	14	2.8	41	8.2	7	1.4	150	30	288	57.6	2157	4.314	Critical

d) Level of Service (LOS) of Road Segments along the Selected Roads

The results of the level of service of the road segments are presented in Table 5.

Table 5: Level of Service of Road Segments

Road	Segment	V/C	LOS
East-West Road	Rumuodara	0.90	D
	Rumuosi	0.96	E
	Alakahia	0.85	D
	Choba	0.95	E
Port Harcourt-Aba Expressway	Leventis	0.88	D
	Government Craft Centre	0.72	C
	St Johns	0.91	E
	Pleasure Park	0.74	C
	Air Force	0.92	E
Ikwerre Road	Mile 3 Market	0.97	E
	Nkpolu- Oruwurokwo	0.91	E
	Rumueperikom/Kala	0.82	D
	Rumueme	0.81	D
	Rumuigbo	0.77	C

Ada George Road	Agip	0.91	E
	Chinda	0.86	D
	Open Door	0.84	D
	Gateway	0.88	D
	Okilton	0.90	D
Rumuokwuta-Choba Road	GGSS Rumuokwuta	0.96	E
	NTA	0.91	E
	Ozuoba	0.93	E
	Choba	0.96	E

This study has utilized the LOS for the assessment of the impact of pedestrian crossing behavior. The LOS in Table 5 shows the V/C value of the road segments ranging from 0.72 to 0.97 which means smooth to low traffic flow with an affected speed and high vehicular density. This is a true reflection of the roads in Port Harcourt. However, at Rumuigbo, Pleasure Park and Government Craft Centre segments along Ikwerre road and Port Harcourt-Aba Expressway Road respectively, the speed are observed to be higher.

IV. Conclusion

The study identified the factors affecting pedestrian crossing behavior and has used LOS to illustrate how pedestrian crossing behavior affects the traffic flow characteristics of roadways in Port Harcourt City. This study found that age, gender, lack of crossing facilities, use of mobile phones, location of crossing facility, educational awareness are the major factors responsible for pedestrian crossing behavior. It has also been determined through analysis that more people cross the street during rush hours, which causes significant traffic congestion at the selected road segments as a result of no crossing facilities especially at midblock crossings. Also, at signalized intersections, the conformance rate of 73.19% shows that pedestrians here in Port Harcourt can obey traffic rules if the infrastructural systems needed are provided which is better when compared to the study of Mumbai in India according to Marisamynathan & Perumal (2014).

V. Recommendation

The following recommendations are put forward to improve pedestrian crossing behavior and traffic flow along roadways in Port Harcourt.

i. The government should carryout a proper traffic survey along major roads in Port Harcourt and provide crossing facilities at relevant locations.
ii. The government should carryout continuous educational awareness campaigns which will help road users to be acquainted with road signs, signals and regulations. This should start from the nursery school level.
iii. Data regarding road accident and pedestrian behavior are lacking in this part of the world. Hence, government should help in making such information available.

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