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Pedestrian crossing: Analysis of habits and compliance through unsignalized crosswalk in the city of Kigali

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ABSTRACT

Pedestrian safety is a global issue that can be improved by monitoring and adjusting walking behaviors. This study focuses on how people walk across streets without traffic signals. It looks at whether pedestrians follow the rules and regulations for safely crossing streets. The unique aspect of this research is that it examines pedestrian behaviors on roads with two lanes for two-way traffic at various informal crosswalks rather than on one-way streets. The researchers watched video recordings to study different instances of people crossing streets. They found that 27.21% of pedestrians followed the safety rules when crossing, but a significant number did not and should be taught better crossing practices. The study identified three main behaviors that often led to rule violations: not looking both ways before crossing, being distracted, and not crossing cautiously. Pedestrians who were cautious were much more likely to follow the crossing rules compared to those moving at any speed, and those not distracted were more likely to follow the rules than those who were cautious. Additionally, 32.05% of pedestrians were distracted by activities like using phones, talking, or wearing headphones. Among these, 17.7% walked directly across the crosswalk, and 26.21% crossed in a diagonal or zigzag pattern. The study also found that 60% to 87% of the observed behaviors could predict whether a pedestrian would follow crossing rules based on statistical models.

1. Introduction

Road safety is endangered by high levels of motorization, and this contributes to road accidents where several people may be killed and injured (Antov et al., 2013). Today, people experience difficulty and danger in crossing roadways in urban cities (TSO, 1995), and crossing amenities are needed to ensure that their easy and safe movement is guaranteed. As far as road safety is concerned, specifically in Kigali (Mukamana, 2015) highlighted that Drivers' compliance with crosswalks is low, and many young drivers are less compliant, and this confirms that Pedestrians are still vulnerable to accidents and a considerable number of deaths and injuries continue to occur in low-income countries including Rwanda. It can be noted that pedestrian risk is still high and may sometimes be difficult and not predictable (Papadimitriou et al., 2016) among road users. Pedestrian crossing still has the biggest risk level among all kinds of pedestrian facilities (Pashkevich et al., 2016).

Pedestrian safety has grown to be a worldwide challenge due to the harm and loss of people's lives (Hasan and Hasan, 2022). Road crossing is among the typical problems and challenges of pedestrians, and it puts their safety level at a low level in Kigali (Nkurunziza and Tafahomi, 2020). Bharath et al. (2018) indicated that about 50% of all trips in major African cities are made entirely on foot, and this shows how pedestrian safety should matter. It has also been realized that pedestrian volume and connectivity at crosswalks in Kigali appear to affect the ease of a pedestrian crossing (Mukamana, 2015). Safety at crossings is ensured by the provision of proper facilities. The lack of some facilities like zebra crossings was found (Nkurunziza et al., 2021a) as an

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extra cause of traffic injuries. The level of safety at crossing generally depends on its features, how it is used by pedestrians, and traffic vehicle characteristics (Basile et al., 2010). King (2003) highlighted that any changes to the roadway would also affect roadway safety. In Rwanda, historical traffic counts at recurring counting stations showed high variances in growth rates, pointing to a combination of unreliable or unstandardized data for the prediction of traffic flow characteristics. However, the rise in vehicles on the road has reduced the safe, smooth mobility of pedestrians (Pandey et al., 2021).

This research aimed to look at existing selected crosswalk facilities (zebra crossing) to analyze pedestrian walking habits and compliances. The study focused only on un-signalized crosswalks to investigate how some policies, rules, and guidelines for crossing were being implemented by pedestrians in the City of Kigali. The statistical results indicated that 27.21% comply with the crossing policy, rules, and guidelines in the City of Kigali, whereas the remaining 72.79% do not. There is a need to improve the transportation system through infrastructural interventions and user training (Riaz et al., 2022). The summary model is written down as shown in Table 1. It was found to be significant with ($Chi^2(9) = 550.32$, $p < .001$, $n = 599$ to predict the value "Comply" that was an investigation.

Table 1: The summary model of the investigation

-2 Log-Likelihood	Cox and Snell R^2	Nagelkerke R^2	McFadden's R^2
150.93	0.6	0.87	0.78

2. Literature review

2.1. Pedestrian fatalities and vulnerability

Around 21% of all road traffic fatalities were assigned to pedestrians in European countries by the year 2008 (Basile et al., 2010). It has been reported by WHO (2018) in the year 2018 that at least 50% of people's deaths on worldwide roads occur at pedestrian crossings, and this shows how sensitive it is. Pedestrians and vehicle trajectories are more likely to collide and crash on city roads due to limited space (Yang et al., 2022). In Europe, particularly in Poland, over 30% of fatalities happen on roads and involve pedestrians because of the available infrastructures and behaviors of drivers or pedestrians (Budzynski et al., 2021). Therefore, a higher risk to pedestrians is still persistent in urban areas (WHO, 2013a), specifically for young people aged 5-29 years (WHO, 2022).

According to the World Health Organization (WHO), around 1.3 million people are killed yearly due to road traffic crashes (WHO, 2022), with more than half of all road traffic deaths dedicated to vulnerable road users, including pedestrians. Alarmingly, the majority of the world's fatalities on the roads occur in low- and middle-income countries at the rate of 93%. However, pedestrians experience great difficulty in crossing as most of the drivers don't care for their waiting (Ibrahim et al., 2005). Presti et al. (2011) published that 76.62% of accidents occur in urban areas, with 13% of them involving pedestrians, of which about 30% of accidents occurred near some facilities in Italy. In brief, there should be an obvious planning relationship between the level of development and the level of car ownership to tackle the prevailing pedestrian fatalities and vulnerability.

2.2. Accident occurrence and risks to pedestrians

The risk of pedestrian fatalities increases when vehicles travel at speeds between 50 to 65 km/h. Therefore, incorporating traffic calming strategies, such as creating safe crossing points, is crucial in road design to minimize pedestrian injuries (WHO, 2022). Some researchers emphasized that the sense of safety provided by the crosswalks is not real and proposed further studies on the behaviors of pedestrians and drivers (Gitelman et al., 2012). To minimize some risks to pedestrians crossing, some crosswalk treatments have been found to affect motorist compliance, including the number of lanes being crossed and the posted speed limit. Often, a statistical inadequacy creates problems for accident ranking, as the number of registered accidents is often too small for better analysis (Antov et al., 2011).

The risk of a pedestrian conflict with a vehicle is very much governed by the pedestrian's decision-making rather than by the drivers (Sun et al., 2022). Crossing can be influenced by the level of understanding and application of existing rules, policies, standard behavior, and guidelines (Brewer et al., 2006) for a particular person. In practice, Obeid et al. (2017) suggested that traffic calming techniques to reduce the risks to pedestrians can be proposed to effectively minimize accident occurrence.

2.3. Need and purpose of road safety at the crosswalk

Crosswalks are established to mark specific areas where pedestrians are allowed to cross streets, making it easier for drivers to see them and yield. The primary purpose of providing crosswalks is to enhance the safety of all pedestrians and to make urban environments more pedestrian-friendly. It is observed that a significant number of pedestrian-related accidents occur near these designated crossing areas.

Li et al. (2013) suggested some crossing behaviors and characteristics of child pedestrians, including speed, waiting time, looking or not looking before crossing, and street running, for establishing crossing laws for consideration during the design of crosswalks specifically for primary children. This indicates how safety at crosswalks covers all aspects of pedestrians, from young adults to old ones.

Chaudhari et al. (2021) found that for road safety at crosswalks located on high-speed multilane roads, pedestrians would experience a significant conflict rate. Crosswalks are found in a commercially abundant environment, and pedestrian safety is more guaranteed because driver compliance is experienced due to land use. Some researchers realized that installing the crosswalk did not have any significant effect on the pedestrians' sensitivity to the waiting time at a crosswalk. However, it contributed to reductions in the speed of approaching vehicles (Danaf et al., 2020).

2.4. Pedestrian challenges and factors affecting their crossings

To be specific, pedestrians face a lot of challenges in an urban area, but we shall limit road crossing challenges as our topic of interest. Road crashes at a pedestrian crosswalk are a very rare event (Montella et al., 2010). The primary issue facing pedestrians is their safety in relation to the existing traffic conditions. Additionally, the urban setting presents obstacles for certain groups, such as children and the elderly, due to its complex road crossing structures at intersections, which differ from those in more familiar environments.

Sisiopiku and Akin (2003) realized that un-signalized midblock crosswalks are the treatment of preference to pedestrians (83%) with a high crossing compliance rate of pedestrians (71.2%). Practically pedestrian injuries occurring at un-signalized pedestrian crossings where pedestrians should theoretically be safe still exist (Olszewski et al., 2016) and is a challenge to their safety. Lamentably, the pedestrian environment is nowadays unfriendly and has become worse in most commercial urban zones (Nahar et al., 2019).

WHO (2013b) highlighted some pedestrian challenges as Inadequate visibility, the lack of pedestrian facilities, failure to plan pedestrian access/crosswalk (Sleet et al., 2011; Ewing and Dumbaugh, 2009), and other challenges like distractions and attitude of drivers and pedestrians altogether. Some factors affect the crossing of roads safely; meanwhile, the location of crossings and crossing dimensions in terms of width and length can greatly contribute to safety increases or worsening. To avoid accident occurrence, some physical barriers to channel pedestrian flows to crosswalks may be necessary to create high spatial crossing compliance (Akin and Sisiopiku, 2007). Pedestrians' exposure along a trip is significantly affected by crossing choices, as well as by road and traffic characteristics (Papadimitriou et al., 2012).

A pedestrian perceives, integrates, and responds depending on the context (Tong and Bode, 2022), and this governs him to perform his road crossing activity, but some special cases of distracted pedestrians (O'Dell et al., 2022) at crosswalks may exist, and some interventions are required to study their source.

2.5. Pedestrian facilities and their contribution to safety

Any bad design of a pedestrian facility might provide a low level of service linked to discomfort in using them (Cepolina et al., 2015). Facilities provided for pedestrians are generally intended to reduce pedestrian conflicts that may arise with vehicles. Properly designed and placed crosswalk facilities greatly serve pedestrians, increase pedestrian compliance, and encourage crossing at designated places (Akin, 2000). Pedestrian facilities are needed in Cities and Towns to assist in playing a vital role in promoting economic growth and prosperity (Nandkishor et al., 2019) in the urban environment.

Some researchers have outlined the benefits of pedestrian facilities (i.e., zebra crosswalks) and their contribution to safety like permitting pedestrians to cross in an orderly manner (Yang et al., 2022), facilitating crossing with perceived behavior control (O'Dell et al., 2022), giving priority to pedestrians waiting to cross (Budzynski et al., 2021), improving the living environment conditions of pedestrians (Zandieh et al., 2016) and managing the vehicle traffic volume. It should be noted that convenient and visible crosswalk facilities (Zegeer et al., 2002) are necessary to ensure pedestrian safety.

3. Results and discussion

3.1. Methodology, aim, and sampling techniques

The research employed both quantitative and qualitative methods to analyze the compliance of pedestrians while crossing at un-signalized sampled selected sites (Nkurunziza et al., 2021a; Nkurunziza and Tafahomi, 2020; Yang et al., 2022; Sun et al., 2022; Basile et al., 2010) within the City of Kigali. Sampling selected sites to analyze crossing were chosen to be characterized by lane two-way roads; this is based on the finding that two lanes involve more risk than crossing one lane, given similar traffic flow (Olszewski et al., 2020). Road crossings through two or more lanes in one direction are dangerous due to very limited sight distance and high vehicle speeds (Szagala et al., 2022). The choice or preference of sampling at un-signalized crosswalks was based on the fact that most of the crashes tend to occur at un-signalized locations (Mir, 2022). Apart from that, other qualitative techniques were used for graphical analysis through photography to acquire some key information (Tafahomi, 2021a; Tafahomi and Reihaneh, 2021) through the investigation of graphical features (Tafahomi, 2021b).

The quantitative methods and techniques were used for the structured observation to study the behavioral patterns of the users (Nkurunziza et al., 2021b; Budzynski et al., 2021; Malik et al., 2022). The quantitative methods utilized the statistical data to define results based on the software output (Antov et al., 2013; Nyirajana et al., 2021; Nkurunziza et al., 2021b; Nkurunziza, 2020).

Particularly, statistical tests and binary logistic regression models were applied to measure dependent and independent variables and evaluate the level of pedestrian compliance at crosswalks (Sperandei, 2014; Moore et al., 2013). The safety of pedestrians presents a serious concern in urban areas with busy roads, and this is the most challenging current topic. Urban traffic has grown and become a challenge to pedestrians, putting their lives in a chaotic situation due to frequent collisions and conflict at crosswalks (Prakash and Karuppanagounder, 2023). Gathering information about pedestrian compliances at crosswalks would help plan and improve safeguarding their life through various appropriate means. This research aims to portray whether pedestrians in the City of Kigali comply or do not comply with the safe crossing behavior at designated crosswalks. The objectives of this research may be broken under the following:

- To look into the Compliant Independent Variables at crosswalk fitting in the context of the City of Kigali;
- To evaluate the level of compliance for pedestrians in the City of Kigali at a crosswalk concerning the applied compliant independent variables.

It is known that areas with an increased pedestrian crash risk have generally relied on roadway characteristics, including geometry, traffic volumes, and number of lanes (Torbic et al., 2010).

In total, 10 data collectors were deployed to different sites for one week (7 days) during peak hours to investigate walking habits with the help of cameras mounted in hidden locations, which allowed for almost purely anonymous observation. The selected crossings for observations were those limited to the following seven factors:

- Apparent existence of relatively high pedestrian mobility near hospitals, markets, schools, and churches
- Existence of physical stop lines (white lines that mark the beginning of a zebra crossing)
- No existence of traffic police or traffic cameras that may distract pedestrians
- No road humps before or after the crosswalk
- No intersection around the crosswalk
- No roundabout around the crosswalk
- Only for one carriageway with 2-way traffic

The study focused on two locations, "Kuri40" and "Kinamba-Bridge," which were chosen for their high levels of vehicle and pedestrian activity during crossing times. Observations were primarily conducted on Thursday mornings from 6:00 to 8:00 AM, a period identified to have a significant amount of activity based on a week of video recording data. The research utilized a set of standards, guidelines, policies, laws, and rules to evaluate whether pedestrians crossed streets safely or unsafely. It was presumed that no external or internal factors influenced pedestrians at crosswalks, assuming these factors were either overlooked or disregarded. Additionally, the study considered ways to improve crossing facilities (Pervaz and Newaz, 2016).

3.2. Research scope, design, and data capture

This research is conducted within the City of Kigali, and the choice of locations was guided by seven specific factors mentioned earlier. The study focuses on different types of pedestrian crossings, with a particular emphasis on marked crosswalks that have zebra stripes. It is generally assumed that marked crosswalks lead to a higher rate of adherence to crossing rules (Fayyaz et al., 2019).

The research is designed to be able to differentiate types of compliance that a pedestrian has to deal with for safe or unsafe crossing behavior, as shown in Table 2, and apply them throughout the research (O'Dell et al., 2022; TSO, 1995; Brewer et al., 2006; Zhuang and Wu, 2011).

Data collected as per the stated observational protocol were subjected to review, screening, and update where necessary to extract the useful ones for pedestrian compliance evaluation at crosswalks. The data extraction from recorded video of pedestrian crossing events has been achieved manually (Morris et al., 2013) for this study, as shown in Table 3.

Table 2: Compliant standards, guidelines, policies, and rules

Compliant	Compliant independent variables at a crosswalk
Crossing standard	walking speed, waiting period/waiting delay
Crossing guidelines	Within crosswalk (in area or out), walking defensively (focused), distraction status (phone, talking, etc.)
Crossing policy	At crosswalk (status-out of or in)
Crossing rules	Straight, not run, look attentively (keep looking left and right sides attentively)

Table 3: Summarized data capture at crosswalks

Site name	Crosswalk events	Observed pedestrians
Kuri40	234	350
Kinamba-Bridge	176	249

The same data were critically and deeply analyzed using statistical analysis tools (Sperandei, 2014) and by applying the required statistical tests (Moore et al., 2013) for their validity. The application of a Binary logistic regression model (Khatoon et al., 2013) was relied on to generate some important results to be discussed in the research. Study sites were also characterized by the measured data in Fig. 1. A Mann-Whitney U-Test was applied to the video-extracted data about moving in /at crosswalks, defensive walking, distraction status, observed crossing practices, left and right-looking behaviors, and running practices. Table 4 summarizes the test results.

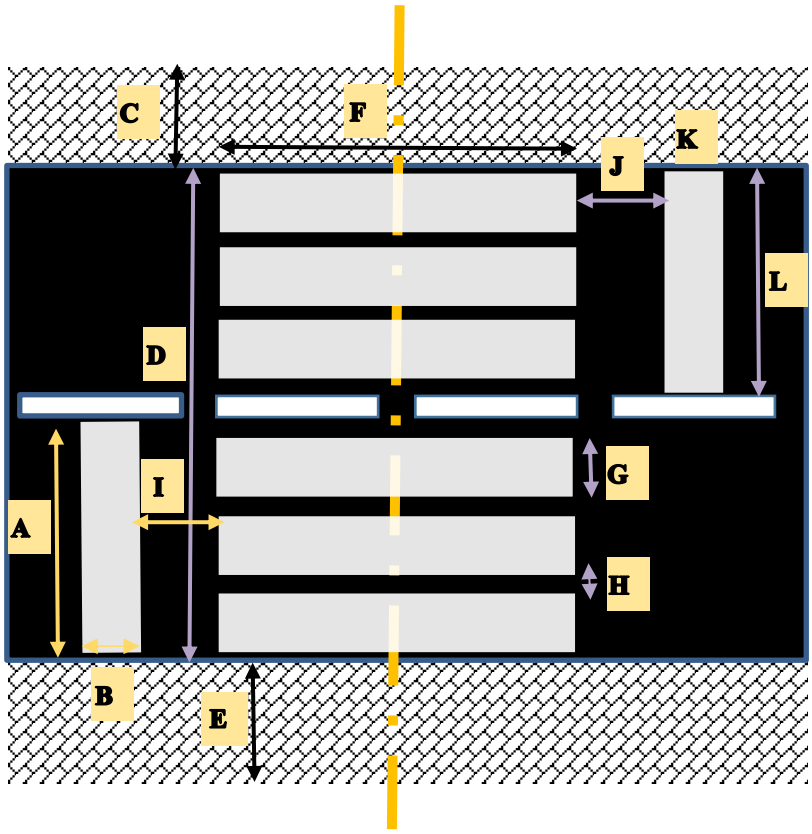

Fig. 1: Crosswalk dimensional layout

Table 4: Results of Mann-Whitney U-Test

Tested data	U	P	r	Dependent variable pedestrian compliance	Null hypothesis decision
In/Out of the crosswalk area	8397	<.004	0.15	statistically significant	rejected
Defensive/Un-defensively walking	22912	<.001	0.55	statistically significant	rejected
Non-distraction/Distraction	23723.5	<.001	0.41	statistically significant	rejected
Move at crosswalk/ Not move at crosswalk	18297.5	<.001	0.22	statistically significant	rejected
Straight/Non-straight crossing practice	23399	<.001	0.32	statistically significant	rejected
Not running/Running practice	17490	<.001	0.28	statistically significant	rejected
Looking/Not looking attentively	23723.5	<.001	0.5	statistically significant	rejected

U (Mann-Whitney U statistic): A lower U value typically indicates a more significant difference between the groups; P (Asymptotic p): A p-value of <.001 is below the common significance threshold of .05, suggesting that the result is significant at the 5% level; r (Effect size): This is a measure of effect size and indicates the magnitude of the difference between groups

3.3. Description of the dataset results

In this study, 599 pedestrians were observed across 410 events to understand their behaviors at crosswalks. The average walking speed was found to be 1.16 meters per second, with the slowest and fastest speeds recorded at 0.62 and 2.63 meters per second, respectively. Statistical analysis (Chi-square = 550.32, degrees of freedom = 9, p-value < .001, sample size = 599) was applied to these observations.

The analysis also compared the waiting times of pedestrians who follow the rules (compliant) versus those who do not (non-compliant). According to the findings, as shown in Fig. 2, compliant pedestrians waited for an average of 4.27 seconds before crossing, whereas non-compliant ones waited for about 3.42 seconds. This indicates that following the rules and being patient at crosswalks typically requires dedicating more time before crossing.

The observed pedestrians have a positive habit of moving in a crosswalk area, cross at crosswalk stripes, and do not run in action at the rates of 93.16%, 83.31%, and 82.3%, respectively, and this is a good sign of complying with accepted crossing policy, rules, and guidelines.

Surprisingly, the negative habits and apparent weaknesses are merely recorded in walking defensively and contributory negligence for left and right looking before initiating any crossing activity, with critical scores of 52.92% and 59.27%, respectively. The statistical results in Table 5 indicate that 27.21% may comply with the crossing policy, rules, and guidelines in the City of Kigali, whereas the remaining 72.79% do not follow. The results testify that there is a need for a strong contribution from the human and engineering fields to obtain a more positive change in the safety of vulnerable road users (Mako, 2015).

Statistical results in Table 6. show that 6.84 % of pedestrians experience a habit of moving out of the crosswalk area while crossing, but interestingly, a large portion of 93.16% practically move in an intended crosswalk area. Pedestrian crossing under distraction is expressed in Table 7, with statistical information that 32.05 % are distracted, and this is endangering their safety.

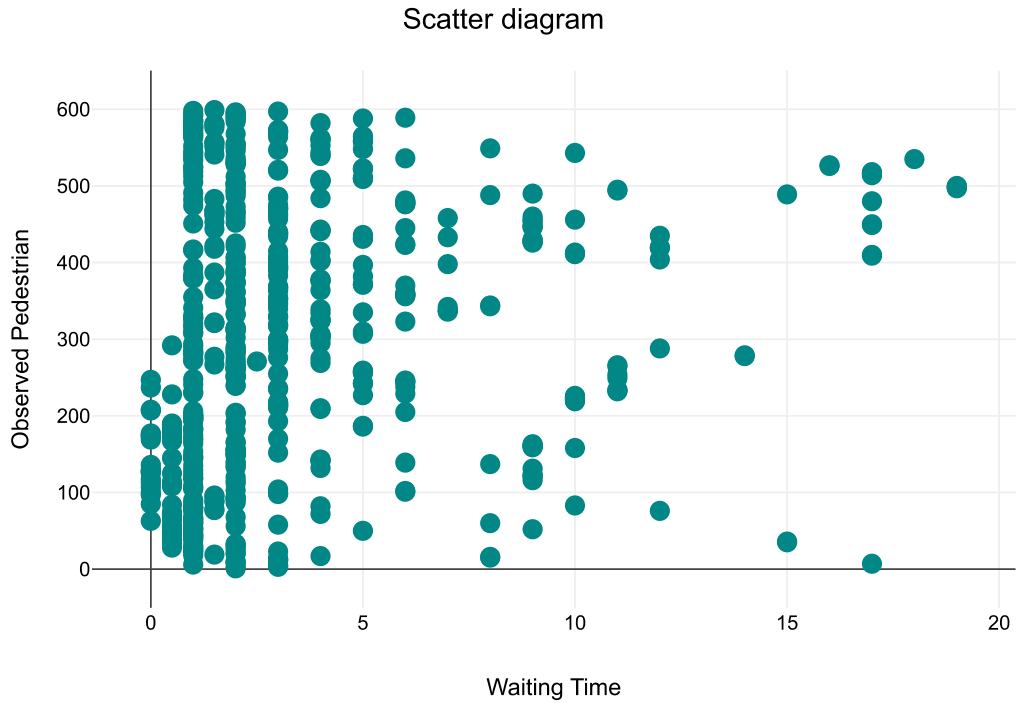

Fig. 2: Waiting time in seconds vs observed pedestrian numbers

The running practice through the crosswalk is generally avoided by the majority of pedestrians, as indicated in Table 8, with 82.3% of pedestrians deflecting such behavior. Crossing straight through the crosswalk is considered a safe behavior, and according to the data presented in Table 9, 73.79% of pedestrians at the surveyed locations follow this good practice for their safety. However, the data in Table 10 highlights a problem with pedestrian negligence, showing that 40.73% of pedestrians do not prioritize looking left and right before crossing, which is a concern for public safety. It was observed that some people do not pass at the Crosswalk indicated Places but opt to use another not marked crossing, which is in the range of 16.69% as per Table 11. A warning about this must be delivered to stop such misconduct. Table 12 illustrates the defensive and non-defensive walking habits to indicate that 47.08% of pedestrians move un-defensively, and this is a safety issue as far as urban road crossing is concerned.

Table 5: Level of pedestrian compliance

Pedestrian compliance	Frequency	%
Not comply	436	72.79%
Comply	163	27.21%
Total	599	100%

Table 6: Pedestrian compliances in the crosswalk area

		Not comply	Comply	Total
In crosswalk area	Move-in crosswalk area	66.11%	27.05%	93.16%
	Move out of the crosswalk area	6.68%	0.17%	6.84%
	Total	72.79%	27.21%	100%

Table 7: Pedestrian compliance with distraction habits

		Not comply	Comply	Total
Pedestrian distraction	Move with distraction	31.89%	0.17%	32.05%
	Move with non-distraction	40.9%	27.05%	67.95%
	Total	72.79%	27.21%	100%

Table 8: pedestrian compliance with running habits

		Not comply	Comply	Total
Running	Not running practice	55.09%	27.21%	82.3%
	Running practice	17.7%	0%	17.7%
	Total	72.79%	27.21%	100%

Table 9: Pedestrian compliance with crossing habits

		Not comply	Comply	Total
Straight Crossing	Straight crossing practice	47.41%	26.38%	73.79%
	Non-straight crossing practice	25.38%	0.83%	26.21%
	Total	72.79%	27.21%	100%

Table 10: Pedestrian compliance looking habits

		Not comply	Comply	Total
Look attentively (Left/Right)	Looking attentively	32.22%	27.05%	59.27%
	Not looking attentively	40.57%	0.17%	40.73%
	Total	72.79%	27.21%	100%

Table 11: Pedestrian compliance at the crosswalk place

		Not comply	Comply	Total
At crosswalk place	Move at crosswalk	56.93%	26.38%	83.31%
	Not move at crosswalk	15.86%	0.83%	16.69%
	Total	72.79%	27.21%	100%

Table 12: Pedestrian compliance with defensive walking habits

		Not comply	Comply	Total
Walking defensively	Walking defensively	26.38%	26.54%	52.92%
	Walking un-defensively	46.41%	0.67%	47.08%
	Total	72.79%	27.21%	100%

3.4. Results of the regression analysis

Logistic regression analysis was performed to predict the categorical or dichotomous variable of complying or not complying with safe crossing at the selected crosswalks from a set of independent variables that include the walking Speed, Waiting Time, moving in the crosswalk Area, Walking Defensively, moving with Non- distraction, moving at the Crosswalk, Straight Crossing Practice, Not Running Practice, and Looking Attentively.

The variables were derived from predefined standards, guidelines, policies, and rules of habits and behaviors for pedestrians at the crosswalks in urban areas. Logistic regression analysis shows that the developed model as a meaningful whole is significant ($Chi^2(9) = 550.32$, $p < .001$, $n = 599$).

3.4.1. Model results

From the model results of the regression analysis with the help of data tab statistical software, the research found that out of 599 total cases of events for compliance (complying) and non-compliance (Not complying). 96.16% of events, equivalent to 576 assignments of pedestrian crossing events, are valid and prove the significance of the model.

3.4.2. Classification table

The regression analysis helps to understand whether crossing through the crosswalk by the pedestrian complies or does not comply with the set of independent variables originating from crossing standards, guidelines, policies, and rules. Table 13 gives the summary results of predicted and observed levels of compliance and non-compliance at the crosswalks. It again reveals that 97.25% of the crossing events by the pedestrians were correct for not complying with the crossing, whereas 93.25% were correct for complying with the crossings.

Table 13: predicted and observed classification results

		Predicted		
		Not Comply	Comply	Correct
Observed	Not comply	424	12	97.25 %
	Comply	11	152	93.25 %
	Total	435	164	96.16 %

3.4.3. Model summary

The model (Pedestrian Compliance) is explained between 60% (Cox and Snell R2) and 87% (Nagelkerke R2) of the variance in pedestrian habits and correctly classified 96.16% of cases (Table 1). The positive predictive value was 93.25%, and the negative predictive value was 97.25%.

3.5. Discussion

Logistic regression analysis was performed to examine the influence of Walking Speed, Waiting Time, moving in a crosswalk Area, Walking Defensively, moving with Non-Distraction, moving at a Crosswalk, Straight Crossing Practice, Not Running Practice, and Looking Attentively on variable Pedestrian Compliance to predict the value "Comply." Logistic regression analysis shows that the model as a whole is significant ($Chi2(9) = 550.32$, $p < .001$, $n = 599$), and discussions are based on Table 14 to the coefficients of the variables. The coefficient of the variable Walking Speed is $b = -0.05$, which is negative. This means that an increase in Walking Speed is associated with a decrease in the probability that the dependent variable is "Comply." However, the p-value of 0.96 indicates that this influence is not statistically significant. The odds ratio of 0.95 indicates that a one-unit increase in the variable walking speed will increase the odds that the dependent variable will "Comply" by 0.95 times.

The coefficient of the variable Waiting Time is $b = 0.13$, which is positive. This means that an increase in Waiting Time is associated with an increase in the probability that the dependent variable is "Comply." However, the p-value of 0.051 indicates that this influence is not statistically significant. The odds Ratio of 1.14 indicates that a one-unit increase of the variable Waiting Time will increase the odds that the dependent variable is "Comply" by 1.14 times.

The coefficient of the variable Move in crosswalk Area is $b = 3.37$, which is positive. This means that if the value of the variable is Move in crosswalk Area, the probability of the dependent variable being "Comply" increases. The p-value of 0.012 indicates that this influence is statistically significant. The odds ratio of 29.08 means that if the variable is Move in crosswalk Area, the probability that the dependent variable is "Comply" increases by 29.08 times. The coefficient of the variable Walking Defensively is $b = 4.51$, which is positive. This means that if the value of the variable is Walking Defensively, the probability of the dependent variable being "Comply" increases. The p-value of $<.001$ indicates that this influence is statistically significant. The odds ratio of 90.87 means that if the variable is Walking Defensively, the probability that the dependent variable is "Comply" increases by 90.87 times.

Table 14: Variable results from the model

Variables	Coefficient B	Standard error	z-value	p-value	Odds Ratio	95% conf. Interval
Walking speed	-0.05	1.09	0.05	0.963	0.95	0.11 - 8.01
Waiting time	0.13	0.06	1.95	0.051	1.14	1 - 1.29
Move out of the crosswalk area	-3.37	1.34	2.51	0.012	0.03	0 - 0.48
Walking Un-defensively	-4.51	0.64	7	<.001	0.01	0 - 0.04
Move with Distraction	-5.95	1.13	5.26	<.001	0	0 - 0.02
Not Move at Crosswalk	-0.44	0.85	0.52	0.601	0.64	0.12 - 3.38
Non-straight crossing practice	-3	0.65	4.62	<.001	0.05	0.01 - 0.18
Running practice	-24.5	7330.49	0	0.997	0	0 - Infinity
Not looking attentively	-6.25	1.2	5.21	<.001	0	0 - 0.02
Constant	2.1	1.36	1.54	0.123		

Z-value: calculated as the coefficient divided by its standard error. It's used to test the null hypothesis that the coefficient is zero (no effect); P-value indicates the probability of observing the data (or something more extreme) if the null hypothesis is true. A lower p-value suggests that the null hypothesis (of no effect) is less likely

The coefficient of the variable Move with Non-Distraction is b = 5.95, which is positive. This means that if the value of the variable is Move with Non-Distraction, the probability of the dependent variable being "Comply" increases. The p-value of <.001 indicates that this influence is statistically significant. The odds ratio of 383.07 means that if the variable is Move with Non-Distraction, the probability that the dependent variable is "Comply" increases by 383.07 times. The coefficient of the variable Move at Crosswalk is b = 0.44, which is positive. This means that if the value of the variable is Move at Crosswalk, the probability of the dependent variable being "Comply" increases. However, the p-value of 0.601 indicates that this influence is not statistically significant. The odds ratio of 1.56 means that if the variable is Move at Crosswalk, the probability that the dependent variable is "Comply" increases by 1.56 times. The coefficient of the variable Straight Crossing Practice is b = 3, which is positive. This means that if the value of the variable is Straight Crossing Practice, the probability of the dependent variable being "Comply" increases. The p-value of <.001 indicates that this influence is statistically significant. The odds ratio of 20.18 means that if the variable is Straight Crossing Practice, the probability that the dependent variable is "Comply" increases by 20.18 times. The coefficient of the variable Not Running Practice is b = 24.5, which is positive. This means that if the value of the variable is Not Running Practice, the probability of the dependent variable being "Comply" increases. However, the p-value of 0.997 indicates that this influence is not statistically significant. The coefficient of the variable Looking Attentively is b = 6.25, which is positive. This means that if the value of the variable is Looking Attentively, the probability of the dependent variable being "Comply" increases. The p-value of <.001 indicates that this influence is statistically significant. The odds ratio of 518.67 means that if the variable is Looking Attentively, the probability that the dependent variable is "Comply" increases by 518.67 times.

4. Conclusions

This study allowed us to inform you that the majority of pedestrians at the identified sites in the City of Kigali do not comply with crossing, and this can put their safety at risk. By comparing the variables that describe the walking habits of pedestrians through the crosswalk that include moving in a crosswalk area, walking defensively, moving with non-distractions, straight crossing, looking attentively, running at a crosswalk, walking speed at a crosswalk, waiting time at the crosswalk and moving at crosswalk place have different impacts of significance for complying at the selected crosswalks. The study presented the important walking habits that pedestrians should respect and bear with them as far as their safety at the crosswalk is concerned based on rules, guidelines, and policies firstly by looking attentively, preventing any kind of distraction (phone, headphones), thirdly by walking defensively, fourthly by straight crossing, fifthly by passing in cross walking area, sixthly by cross walking on zebra stripes, evenly by practicing the waiting time before crossing and eighthly by moving with an adequate walking speed. It was found that some of the pedestrian habits do not have an important influence on compliance with crossing behaviors, including running habits, walking speed, and waiting time. It is advised to regularly teach, warn, and inform pedestrians to respect attentive left and right looking before any crossing, avoid any distractions like phone use, headphones, talking while in crosswalk action, and always walk defensively by focusing on the action.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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