# SPATIAL MAPPING OF WALKING HOTSPOTS: EXPERIENCES AROUND SCHOOL ZONES IN CITY OF KIGALI, RWANDA

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## ABSTRACT

Walking is the primary mode of commuting in African cities; however, pedestrians face numerous challenges that negatively impact their walking experience. This study aims to identify pedestrian hotspots and analyze their walking experiences around school zones in the city of Kigali, Rwanda. Data were collected using the Walkability App developed by Walk21, focusing on 12 educational centers. The data collection occurred from May 28 to May 31, 2024, and included responses from 1,339 participants. The collected data captured individual geolocated walking experiences around school zones as well as both positive and negative factors influencing these experiences. To identify hotspots of walking experiences, Getis-Ord Gi statistics were utilized. The analysis of these hotspots was validated through photographs taken during field visits, which were then compared to the hotspot map. The findings revealed that hotspots of negative walking experiences were consistently found around five schools: St. Joseph Le Travailleur Secondary School, Kabusunzu Primary School, Groupe Scholaire EPA-St. Michel, Biryogo Primary School, and Ntwali Primary School. Key factors contributing to the negative walking experiences around each school zone include inadequate and open drainage systems, lack of safe crosswalks, inadequate walking paths, increased traffic flow speed, and the absence of pedestrian pathways. This study demonstrates that an urban environment significantly influences pedestrian walking experience. Most hotspots of negative walking experiences in the City of Kigali are located mainly in the peripheral areas with unplanned settlements, such as Nyakabanda, Nyarugenge, and Rwezamenyo. This information is crucial for developing targeted strategies and interventions to enhance pedestrian walking experience around school zones in the City of Kigali.

**Keywords**: School zones, hotspots, school children, built environment, walking experiences.

## 1. INTRODUCTION

Walking is the primary mode of transportation in Sub-Saharan African (SSA) cities, with up to 78% of people commuting on foot daily (UN-Habitat, 2022). This is particularly relevant for individuals accessing jobs and schools (Memela et al., 2024; Okyere et al., 2024). Walking to school offers significant benefits for children, including improved health through building stronger muscles, enhanced cardiovascular fitness, and the maintenance of a healthy weight (Kelly et al., 2017; Sleap & Warburton, 1993). Moreover, walking promotes social interactions, allowing children to engage with their peers and make new friends (Kennedy & Mammen, 2017). It also aids in developing road safety awareness and navigational skills, essential for fostering independence (Kingham & Ussher, 2007).

Despite these advantages, many roads in African cities fail to provide the necessary safety and comfort to pedestrians. This deficiency contributes to 33% of pedestrian deaths, including those of school children (WHO, 2023).

Evidence indicates that factors contributing to unsafe and uncomfortable walk journeys to school can be grouped into two interconnected categories: built-environmental factors (Stoker et al., 2015; Vergel-Tovar et al., 2020) and human factors (Oguntoyinbo et al., 2024). In Africa, human factors are often identified as the leading cause of road crashes (Austine Taiwo et al., 2024; Osuret et al., 2024). However, a study conducted in the city of Kigali by Wang et al. (2020) on hotspots for road traffic crashes found that built-environmental factors, such as road design and traffic characteristics, are highly associated with these incidents. For instance, the study highlights that exposure to fatal crash risks is influenced by vehicular density and various road safety characteristics, including road paving, road narrowing, characteristics of crosswalks, pedestrian traffic lights, and informal pedestrian walkways (Das, 2023). Moreover, human factors are also affected by road design and traffic characteristics, which in turn have a considerable impact on road accidents. For example, Fu et al. (2011) note that risky driving behaviours, such as speeding, are positively influenced by road design features like continuous descending slopes, where the vehicle's gravity acts as an additional driving force. This can lead to accidents in cases of brake failure. These studies illustrate that the relevant factors contributing to road crashes on the way to school may vary depending on the geographical location of the school. For this reason, it is essential to map walking experiences around school zones and provide transport authorities with compelling evidence to enhance pedestrian safety in these areas.

There is a limited number of studies in Sub-Saharan Africa (SSA) that report on pedestrians' experience around school zones. Most existing research originates from developed countries (Gallimore et al., 2011; Hino et al., 2021; Kweon et al., 2021; Kweon et al., 2023; Liu & Mendoza, 2014; Mehdizadeh et al., 2017; Rossen et al., 2011) and primarily focuses on parents' perceptions regarding how pedestrian environment influences children's safety while walking and cycling to school. For example, a study by Hino et al. (2021) in Chiba, Japan, indicates that parents associate a positive walking experience to school with presence of traffic safety measures, neighbourhood cohesion, and video surveillance systems on the streets. Another study involving 26 parents with elementary school children from Texas (United States of America), found that the presence of sidewalks, tree cover and buffer strips positively influenced their perceptions of positive walking experience to school, increasing their willingness to allow their children to walk (Kweon et al., 2021). The findings from these studies may not be easily applied to the Sub-Saharan Africa (SSA) context, as most roads in SSA cities are unpaved. Additionally, the few quality roads that exist are typically concentrated in the inner city (Lall et al., 2017). For example, a study by JICA (2014) found that approximately 80% of roads in Nairobi City, Kenya, are paved and in good or fair condition. In Dar es Salaam, Tanzania, this figure is about 39% (JICA, 2008), while in Kampala, Uganda, it is 32% (JICA, 2024). The City of Kigali, Rwanda, deepens these differences as only about 15% of roads are paved (JICA, 2019). These statistics significantly indicate lack of basic traffic safety measures, such as walking paths, crosswalks, pavements, and buffer strips, especially in the periphery of these cities. This not only underscores the relevance of the case study but also the urgent need to understand the factors that influence walking experiences in SSA and how pedestrians perceive these factors when navigating school zones in various urban settings. Without such insights, one cannot clearly identify school zones where pedestrians have poor or good walking experience, as urban setting quality in SSA worsens as one moves away from the inner city.

Previous studies indicate that key built environmental factors such as car-oriented road design, land uses with pedestrians' fear of crime and harassment, insufficient or non-existent walking paths, lack of crosswalks, unclean or noisy pathways, inadequate drainage systems, poor lighting, and insufficient greenery and traffic characteristics negatively impact walking experience in Sub-Saharan African (SSA) cities (Avineri et al., 2012; Cobbinah & Finn, 2024; Fileborn & Vera-Gray, 2017; González et al., 2020; He et al., 2020; Khayesi et al., 2010; Koekemoer et al., 2017; Kumar & Barrett, 2008; Okyere et al., 2024; Poku-Boansi et al., 2019; Quinones, 2020; Quinones, Lina Marcela, 2020; Sietchiping et al., 2012; Simons et al., 2018; Sinclair et al., 2025; UN-Habitat, 2022; Van Dijk et al., 2018). For instance, Sinclair and Zuidgeest (2016) point out that in car-oriented road designs, such as Cape Town's motorways, the available crossing options for pedestrians require long walks. Quinones, Lina Marcela (2020) states that verbal harassment discourages walking and often occurs in areas with a significant presence of homeless individuals and street vendors. Sietchiping et al. (2012) mention that in many SSA cities, the absence of walking paths forces motorists to share the road with pedestrians and other modes of transport, turning urban roads into “disputed territory” where pedestrians and cyclists face the greatest risks regarding their safety and accidents. Ma et al. (2010) note that street walking spaces occupied by vehicles, garbage, and poorly maintained roads with inadequate drainage and discontinuous walking surfaces, result in a more challenging street environment for pedestrians. Jacobsen et al. (2009) complement this by stating that when roadways are equipped with sidewalks, nearly four times as many people walk. Avineri et al. (2012) argue that lack of crosswalks contributes to an unsafe crossing environment by increasing conflicts between pedestrians and vehicles. Rahm et al. (2021) highlight that the quality of urban greenery and street lighting significantly impacts people's walking experiences; for instance, after dark, individuals may feel compelled to take detours along unlit streets and streets covered with heavy greenery. Conversely, during sunny days, they tend to choose roads shaded by trees (Segadilha & da Penha Sanches, 2014). Lastly, Jacobsen et al. (2009) indicate traffic flow variables such as traffic volumes and speeds having the strongest association and inverse correlation with levels of walking and cycling due to the dangerous and unpleasant nature of motor vehicle use. Additionally, human factors such as aggressive drivers’ behaviour and speeding are identified as significant factors that negatively affect walking experience. Such behaviours can be influenced by built environmental factors such as road design. For example, a Study conducted by Das (2023) on major roads of Bloemfontein (South Africa) suggested that road width and reduced number of access roads, influence vehicle speed and the incidence of traffic crashes. All these studies have provided a general understanding of how the built environment and human factors influence walking experience. However, it remains unclear how the importance of these factors varies across different urban zones. This is particularly relevant in SSA cities due to dramatic changes in the quality of the built environment and infrastructure along different urban zones.

This study aims to address the gap by identifying and mapping hotspots of pedestrian walking experiences around school zones and examining the built environmental factors associated with these experiences. The structure of the paper is as follows: the second section presents the methods used, while the results and discussion are covered in the third and fourth sections, respectively. Finally, the conclusion and closing remarks are provided in section five.

## 2. METHODS

### 2.1 Case Study Description

The City of Kigali, the capital of the Republic of Rwanda, serves as the case study. The city has an estimated population of 1,788,503 inhabitants (NISR, 2023) and is administratively divided into three districts: Nyarugenge, Gasabo, and Kicukiro. Nyarugenge, which is the Central Business District (CBD), boasts better road infrastructure, including walking facilities. In contrast, only about 14% of the roads in the other districts are paved (JICA, 2019). Topographically, Kigali lies at varying elevations from approximately 1,300 meters to 1,800 meters above sea level. Walking accounts for 52% of the mode share, followed by private motorized vehicles at 31% and buses at 17% (JICA, 2019).

The study area encompasses nine sectors across the three districts of Kigali city. These sectors were chosen for having the highest concentration of educational institutions and pedestrianised streets (car-free zones) and for presenting contrasting urban environments, including compact and unplanned settlements in the southern part of the case study, particularly in Gitega, Nyakabanda, and Rwezamenyo where the roads are narrow and unpaved, with intense informal commerce occurring along the main roads. The Nyarugenge sector features a mix of informal and unplanned settlements in the south, alongside well-planned areas in the north. This pattern is similar to those observed in the remaining northern sectors of the case study, including Muhima, Gisozi, Kinyinya, Remera, and Niboye. These areas exhibit better-planned land use, with wide roads that are a mix of paved and unpaved surfaces.

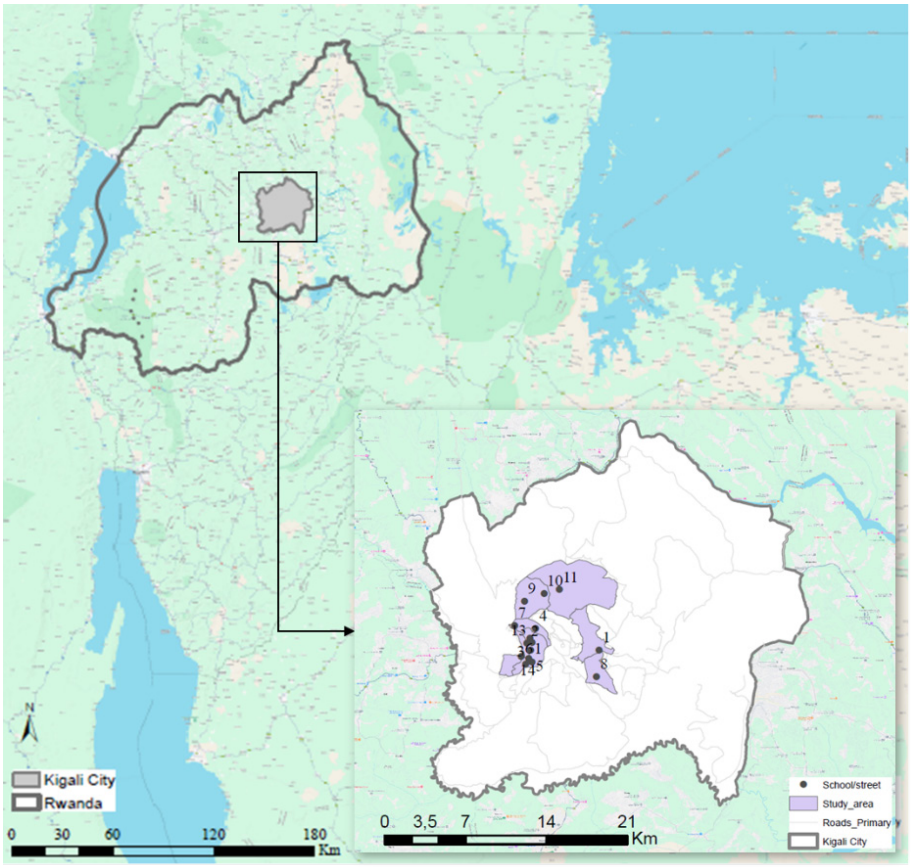


**Figure 1: Case study location**

## 2.1 Data Gathering Process

The empirical data for this study were collected using the Walkability App developed by Walk 21, focusing on 12 educational centers located in different urban zones of the City of Kigali. This App allows citizens of all ages and abilities to share their walking experiences, both in a positive and negative way, and to link such experiences to elements and characteristics of the environment, such as pedestrian pathways, crossings, traffic and pollution, amongst others. As a result, the Walkability app provides relevant information about where pedestrians perceived the walkability of a place in a positive or negative way and the main reasons that influence them (Walk_21, 2024).

The survey took place over four days, from May 28 to May 31, 2024, in 15 locations (12 educational centres and 3 car free zones) across the districts of Nyarugenge, Gasabo, and Kicukiro in Kigali City. The list of the schools and corresponding IDs is presented as follow: Camp Kigali School (1), Groupe Scholaire EPA- St Michel (2), Ntwali Primary School (3), St Joseph Le Travailleur Secondary School (4), Biryogo Primary School (5), Kabusunzu Primary School (6), Muhima Primary School (7), Kicukiro Primary School (8), Glory Secondary School (9), FAWE Girls School (10), Saint Dominic Primary School (11), University of Rwanda (12), Pedestrianised (Centred) (13), Biryogo Car Free Food Street (Part of Biryogo School) (14), Remera Gisimenti Car Free Zone (15). Details about the type of school and geographic coordinates can be referred in Nkurunziza et al. (2024). Respondents were approached within areas less than 1000 meters from 12 primary and secondary schools, as well as the entrance to the university campus in Nyarugenge and within three car-free zones. A total of 1,532 individuals were surveyed.

The Walkability App captures three main types of information to better understand current traffic safety for pedestrians. Firstly, information about the participants of the study and their walk context, such as age, gender, ability to walk and their walking company or familiarity with the place. Secondly, the pedestrian's walking experience, classified as positive, concern, or negative. Thirdly, the environmental factors that influence their experiences, such as car- or people-oriented street design, land use that contributes to pedestrians' fear of crime and harassment, insufficient or non-existent walking paths, a lack of crosswalks, unclean or noisy pathways, inadequate drainage systems, poor lighting, insufficient greenery, aggressive driver behaviour, and speeding for measuring their negative walking experience. All this information is collected for every participant, including the time and coordinates of each observation, which allows further content and spatial analysis on the perceived walkability and its determinants of a place at street level.

## 2.2 Data Analysis Procedure

Two data analysis procedures were followed to map hotspots of walking experiences around school zones in Kigali, which included, hotspots analysis and descriptive statistics.

*Step 1: Hotspots analysis*

Getis-Ord Gi* statistics were utilized to identify clusters of negative (hotspots) and positive (coldspots) walking experiences, as well as to assess the statistical significance of each cluster. The walking experiences were disaggregated for each individual participant, with each individual represented by a point on the map. The walking experiences were classified as follows: Positive = 1, Concern = 2, and Negative = 3, which were used as the input field for analysis. The hotspot analysis, by default, employs a fixed distance band based on Euclidean distance. In this approach, neighboring features within a specified critical distance receive a weight of one, thereby influencing the calculations for the target

feature. Conversely, neighboring features outside the critical distance receive a weight of zero, meaning they do not affect the computations for the target feature. This method ensures that each intersection feature has at least one neighbouring feature.

When interpreting the results, the Gi* statistic calculates a Z-score that indicates how many standard deviations a value is from the mean. The Z-score test values corresponding to the significance of clusters at the 90%, 95%, and 99% confidence levels are ± 1.56, ± 1.96, and ± 2.58, respectively. A cluster is regarded as a hotspot if the Z-score is greater than or equal to +1.56, a coldspot if the Z-score is less than or equal to -1.56, and there is no significance if the Z-score falls between -1.56 and +1.56. Similar to the Z-score values, higher confidence levels suggest a stronger likelihood of clustering as hotspots or coldspots. According to the spatial randomness hypothesis, the identification of hotspots or coldspots is significant at confidence levels greater than 90%. In this study, hotspots indicate a high concentration of individuals experiencing negative walking experiences, while coldspots correspond to a high concentration of individuals experiencing positive walking experiences. This analysis enabled the identification of school zones located in proximity of the hotspots (≤ 95% confidence) regarding walking experiences. The hotspot analysis was conducted using ArcGIS version 10.8, and the results of this analysis are presented in Table 1 and Figure 2.

*Step 2: Descriptive analysis to identify determinants for a negative walking experience*

After identifying clusters of hotspots and school zones near these clusters, descriptive statistics were performed to assess the key determinants of negative walking experiences at each school. This was achieved by ranking for each school the frequency with which each variable, influencing negative walking experiences was cited. The ranking scale ranged from 1 to 12, with a rank of 1 indicating that those variables were frequently cited as influential and a rank of 12 indicating that those variables were rarely mentioned. The most cited variables served to provide transportation authorities with compelling evidence to enhance pedestrian safety in these areas. The results of the analysis are presented in Table 2.

## 3. RESULTS

### 3.1 Hotspots of Walking Experiences

Table 1 shows that, overall, the concentration of hotspots and coldspots is grouped into two clusters of different confidence level. Individuals experiencing a negative walking experience (hotspots) are distributed across 106 points at a 95% confidence level and 306 points at a 99% confidence level. In contrast, individuals experiencing a positive walking experience (cold spots) are distributed across 74 points at a 95% confidence level and 389 points at a 99% confidence level. These points are distributed spatially as presented in Figure 2.

**Table 1: Overall hot spots and cold spots points of walking experiences around school zones**

| Type of clusters | Hotspot points of walking experience | Cold spot points of walking experience |
|---|---|---|
| 99% Confidence | 306 | 389 |
| 95% of confidence | 106 | 74 |

The hotspots for walking experiences are consistently distributed around schools in four sectors of Kigali: Muhima, Nyakabanda, Nyarugenge, and Rwezamenyo (see Figure 2). In Muhima, the highest concentration of hotspots is near St. Joseph Le Travailleur Secondary School, which has 85 hotspot points located along the KN1 St. In Nyakabanda, there are 91 hotspot points along KN199 St, around Kabusunzu Primary School. In Nyarugenge, there are a total of 129 hotspot points, where 69 points are concentrated along KN2 Ave, around Groupe Scholaire EPA-St. Michel and 60 points along the KN150 St, around Biryogo Primary School. Lastly, in Rwezamenyo, there are 80 hotspot points along KN 2 Ave, located near Ntwali Primary School.

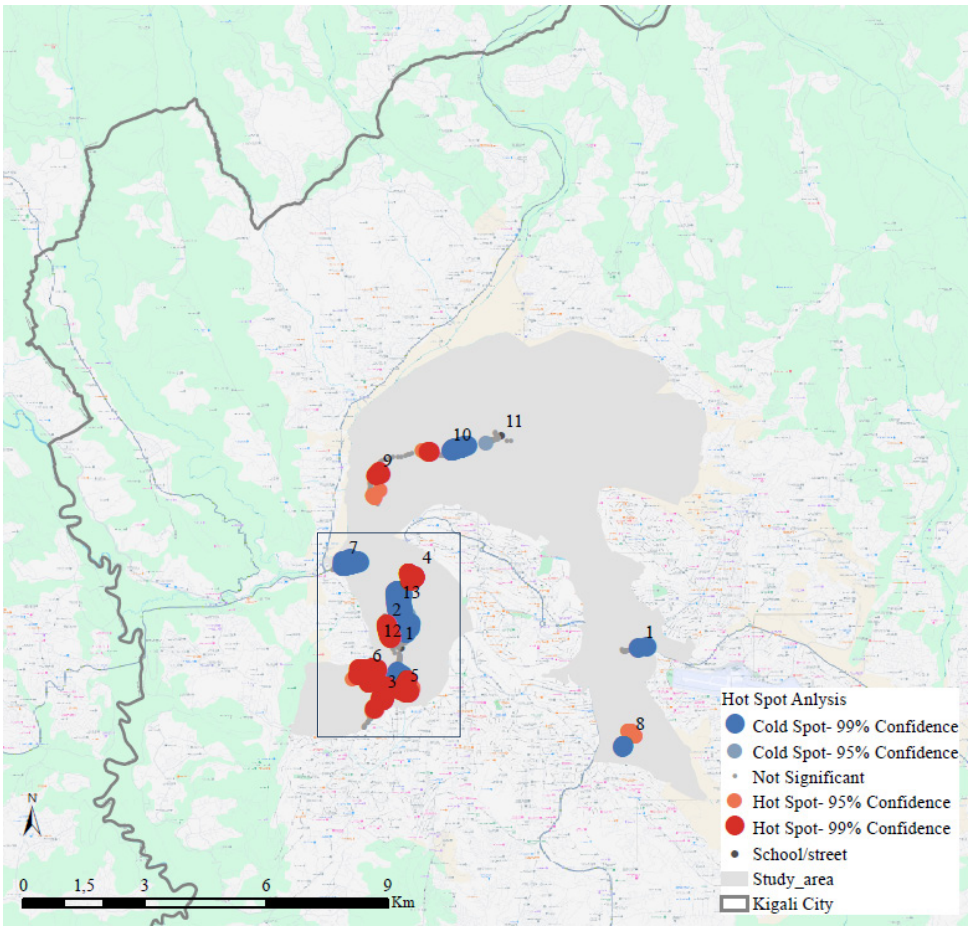


**Figure 2: Hotspot analysis of walking experiences**

(In square is the location of largest number of hotspots presenting ≥ 95% confidence level. The number in the map indicates the ID of each school)

## 3.2 Rank of Determinants of Negative Walking Experience

Table 3 presents the ranking of variables influencing a negative walking experience around schools with the highest concentration of hotspots. At St. Joseph Le Travailleur Secondary School, pedestrians identified inadequate and open drainage system and lack of safe crosswalks as the primary factors contributing to negative walking experience. Meanwhile, individuals traveling around Kabusunzu Primary School, Groupe Scolaire EPA-St. Michel, and Ntwali Primary School highlighted lack of safe crosswalks and insufficient walking paths as the main deterrents to a positive walking experience. Additionally, people walking in the vicinity of Biryogo Primary School pointed to increased traffic speed and the absence of walking paths as the key factors negatively impacting their walking experience.

**Table 3: Rank of determinants for a negative walking experience per school/streets with the highest hotspots**

| Variables Influencing negative walking experience | St Joseph Le Travailleur Secondary School | Kabusunzu Primary School | Groupe Scholaire EPA- St Michel | Biryogo Primary School | Ntwali Primary School |
|---|---|---|---|---|---|
| Lack or Unsafe crosswalks | **2** | **2** | **1** | 4 | **2** |
| Car-oriented road design | 6 | 8 | 5 | 5 | 10 |
| Aggressive Poor drivers behaviour | 12 | 11 | 4 | 8 | 8 |
| Lack of walking Path | 5 | 4 | 3 | **2** | 3 |
| Inadequate and open drainage systems | **1** | 3 | 6 | 3 | 5 |
| Unclean or noisy pathways | 8 | 10 | 8 | 10 | 9 |
| Insufficient walking path | 3 | **1** | **2** | 6 | **1** |
| Insufficient greenery | 7 | 5 | 8 | 7 | 5 |
| Increased traffic speed | 11 | 7 | 7 | **1** | 7 |
| Poor lighting | 4 | 6 | / | 9 | 3 |
| Land use that contribute to pedestrians' fear of crime | 9 | 9 | / | 10 | / |
| Land use that contribute to pedestrians' fear of Harassment | 9 | 12 | / | 10 | / |

## 4. DISCUSSION

This paper identifies pedestrian hotspots and deterrents to positive walking experience around 12 school zones in Kigali, Rwanda. The hotspot analysis assesses the concentration of individuals experiencing negative walking conditions, grouped into two clusters of different confidence levels consistently found around schools in four sectors of Kigali: Muhima, Nyakabanda, Nyarugenge, and Rwezamenyo. In the Muhima sector, the highest concentration of hotspots is near St. Joseph Le Travailleur Secondary School. In Nyakabanda, hotspot points are located around Kabusunzu Primary School. In Nyarugenge, hotspots are concentrated around Groupe Scholaire EPA-St. Michel and Biryogo Primary School. Lastly, in Rwezamenyo, hotspot points are situated near Ntwali Primary School. Key variables influencing the negative walking experience around each school zone include an inadequate and open drainage system, lack of safe crosswalks, insufficient walking paths, increased traffic speed, and the absence of pedestrian pathways. Evidence supporting these findings can be seen in Figures 3a-j.


**Figure 1: Images of built environmental factors contributing to negative walking experience around school zones**

a) Sidewalk along the KN1 St. presents no pavement on sidewalks and drainage (Main road to St Joseph Le Travailleur Secondary School; b) Segments of the KN1 St. presenting unpaved surfaces (St Joseph Le Travailleur Secondary School), c) Sidewalks are inexistent along the KN199 St (Kabusunzu Primary School). d) Narrow road and paved with stones (KN199 St., the main road connecting Kabusunzu Primary School). e) Main entrance to the Groupe Scholaire EPA-St Michel, there are no crossing facilities, f) No physical separation between car traffic and pedestrians on one side of the KN2 Ave, the main road to Groupe Scholaire EPA- St Michel school. g) Narrow sidewalks along KN 2 Ave. (Ntwali Primary School). h) Lack of pedestrian crossing to the main entrance of Ntwali Primary School. i) Main road KN150 St. with steep gradient, near Biryogo primary school. j) Lack of sidewalks on one side along KN150 St.

People walking around St. Joseph Le Travailleur Secondary School identified two main factors contributing to negative walking experience: inadequate and open drainage system and lack of safe crosswalks. This finding aligns with Figure 2, which shows that hotspots around the school are located along KN1 Avenue. Many segments of this road are unpaved and lack proper drainage (see Figure 3a), leading to water accumulation during the rainy season and resulting in an unpleasant walking experience. Additionally, many road segments lack crosswalks, and the pavement consists of a mix of both paved and unpaved areas (Figure 3b), making it difficult to install zebra crossings for safer pedestrian passage. These findings are consistent with Ma et al. (2010), who note that poorly maintained streets, like many parts of KN1 Avenue, create a challenging environment for pedestrians. This issue is particularly pronounced in cities such as Kigali, where clay soil exacerbates drainage problems, resulting in thick mud that is undesirable for many people. This mud soils shoes and clothing and also contributes to the erasure of road markings, such as zebra crossings. To improve the pedestrian experience and safety along KN1 Ave, city authorities should focus on paving the sidewalks to ensure a smooth walking surface. It is also important to pave the roads, particularly around the main entrance of St. Joseph Le Travailleur Secondary School, to avoid dust or mud that can complicate the installation and maintenance of street markings like zebra crossings. This recommendation aligns with UN-Habitat (2018), which states that footpaths with proper surfacing encourage walking. Furthermore, Avineri et al. (2012) cite that the presence of designated crosswalks creates a safer crossing environment by reducing conflicts between pedestrians and motorized traffic.

Individuals traveling near Kabusunzu Primary School, Groupe Scolaire EPA-St. Michel, and Ntwali Primary School report that insufficient walking paths and a lack of safe crosswalks are the main obstacles to a positive walking experience. This aligns with Figure 2, which shows that hotspots around Kabusunzu Primary School are located along KN199 St. Figures 3c-d illustrate that this road is narrow, dirty, and paved with stones, with no sidewalks available. At Groupe Scolaire EPA-St. Michel, the hotspots are found at the junction between KN2 Ave and the road leading to the school's main entrance. Figure 3e highlights the absence of crossing facilities at these hotspot sites, while Figure 3f indicates that sidewalks are present only on one side of the road, exposing pedestrians to traffic hazards. Near Ntwali Primary School, hotspots are located along KN2 Ave. Figure 3g shows that the sidewalks have inconsistent geometry and are too narrow near the junction at Ntwali Primary School, making it difficult for two or more individuals to pass through. Additionally, Figure 3h demonstrates that there are no crosswalks near the school's main entrance. These findings support Sietchiping et al. (2012), who note that lack of convenient walking paths forces pedestrians to share the road with vehicles and other modes of transport, turning urban roads into "disputed territory". This is evident in Figure 3c, where the absence of a convenient walking path leads pedestrians to use the road instead. As illustrated in Figure 3f, there is also lack of physical separation between pedestrians and motorised traffic, exposing them to dangerous interactions with motor vehicles. To improve the pedestrian experience around these schools, policies should focus on introducing sidewalks on both sides of KN2, particularly along Groupe Scolaire EPA-St. Michel, to ensure that people are not forced to use the motor vehicle traffic lanes. Additionally, the sidewalks should be widened to enable safer pedestrian crossings, especially at KN199 around Kabusunzu Primary School and KN2 around Ntwali Primary School. Moreover, there is a need to introduce pedestrian crossings close to the main entrances of Ntwali Primary School and Groupe Scolaire EPA-St. Michel to guide pedestrians when crossing. This recommendation is consistent with UN-Habitat (2018), which states that the absence of footpaths or the presence of narrow sidewalks forces

people to walk on the motor vehicle carriageway. Avineri et al. (2012) also note that lack of crosswalks disrupts the natural flow of traffic, causing confusion for both drivers and pedestrians regarding safe crossing locations, as shown in Figure 3h.

Individuals walking near Biryogo Primary School have identified increased traffic speed and lack of walking paths as the main factors contributing to negative walking experience. This aligns with Figure 2, which indicates that the hotspots of negative walking experiences are concentrated along KN150 Street. This area has a steep slope, illustrated in Figure 3i, which contributes to higher vehicle speeds, particularly for those travelling downhill. Additionally, along this road, a walking path exists only on one side (Figure 3j), which exposes pedestrians to motorised traffic and further detracts their walking experience. These observations are consistent with Fu et al. (2011), who noted that road design features, such as continuous descending slopes, can lead to risky driving behaviors like speeding, as gravity increases vehicle speed. This situation poses a greater risk to pedestrians, especially those using unprotected sidewalks, such as those along KN150 Street. To enhance the pedestrian walking experience, policies should focus on installing physical traffic calming measures that encourage drivers to reduce speed, such as road humps, and providing sidewalks with crash barriers on both sides to protect pedestrians from fast-moving vehicles. This recommendation aligns with Gyaase et al. (2023), who found a significant reduction in fatal injuries involving pedestrians on roads that had been modified with road humps compared to those without. Ribbens et al. (2008) further argue that physical separation between pedestrian and motor vehicular traffic enhances the sense of safety and improves the overall walking experience.

## 5. CONCLUSION

This study identified hotspots of pedestrian walking experiences around twelve school zones in Kigali, Rwanda, and analyzed the various factors influencing these experiences. The highest concentration of negative walking experience hotspots is found along roads near St. Joseph Le Travailleur Secondary School, Kabusunzu Primary School, Groupe Scholaire EPA-St. Michel, and Biryogo Primary School. Key variables contributing to the negative walking experience around each school zone include inadequate and open drainage systems, lack of safe crosswalks, inadequate walking paths, increased traffic speeds, and the absence of pedestrian pathways. This study demonstrates that urban environment significantly influences walking experience as the majority of hotspots, presenting a confidence level of 95% or more, are located in peripheral areas with unplanned settlements, such as Nyakabanda, Nyarugenge, and Rwezamenyo, with the exception of Muhima sector, located in a well-planned urban setting.

This study significantly contributes to the existing literature on the walking experience. Unlike previous research that merely identified the main factors influencing this experience, this study advances the discussion by pinpointing where each factor has the most detrimental impact on the experience of walking. The study also points at potential recommendations to improve the walking experience around school zones. However, the limitation of the study is that data was collected randomly from all individuals who cross school zones, including those who may not frequently travel to these areas. This can skew their perspectives, as their opinions might be based on their most common routes, leading to less accurate information. Therefore, it is recommended that future research focus on the perception of users who regularly walk through school zones, particularly parents of children attending these schools.

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