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An intercept survey of the use and non-use of footbridges in Ghana

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ABSTRACT

Footbridges reduce pedestrian-vehicular interaction and the incidence of pedestrian crashes. Their use significantly reduce the incidence of pedestrian crashes along major highways in low and middle-income countries like Colombia, Ghana, Jordan, Malaysia, and Nigeria. This study seeks to investigate the usage of footbridges in Ghana. A survey was conducted among pedestrians using and not using footbridges at six and one locations in Greater Accra and Kumasi Metropolitan areas respectively. The pedestrians were intercepted in the vicinity of footbridges as users and non-users from 7:00am-9:00am, 11:00am-1:00 pm and 3:00 pm-5:00 pm daily for seven days. In all, 1852 pedestrians were surveyed. The quantitative data was analysed using SPSS v.21 and Structural Equation Modelling (SEM). The study showed that more prevalence among male non-users than females. Those with secondary education, and those who had been previously involved in a pedestrian crash used footbridges the most. The SEM results revealed that age, gender, training in pedestrian safety, frequency of use, walking distance, how often one crosses the stretch road, and length of stay in an area, affect the use of footbridges. An approach by city managers in low and middle-income countries including Colombia, Ghana, Jordan, Malaysia, Mexico, and Nigeria is required to improve the use of footbridges to reduce the incidence of pedestrian crashes. Specifically, officials of the National Road Safety Authority, Ghana Highway Authority and Motor Transport and Traffic Department of the Ghana Police Service should consider these factors affecting footbridge usage in addressing pedestrian safety on Ghanaian highways.

1. Introduction and background

Globally, the safety of vulnerable road users is a chief concern (WHO, 2018). This is even worrisome in low and middle-income countries (LMICs) including Colombia, Ghana, Jordan, Malaysia, and Nigeria (Abojaradeh, 2013; Hasan and Napiah, 2014; Demiroz et al., 2015; Noora et al., 2016; Hasan and Napiah, 2017; Oviedo-Trespalacios, & Scott-Parker, 2017). The roads in LMICs are dominantly vehicle-centric at the expense of vulnerable road users such as pedestrians, cyclists, motorcyclists and tricyclists. Of the various road-users, pedestrians are mostly at risk in terms of sharing and competing for the same narrow road space with other vehicles to socialize, work, school, and access other amenities (Agyapong & Ojo, 2018).

Globally, pedestrians are overrepresented in road fatality statistics accounting for 30% of road fatalities in the African Region and 22.0% in the Americas (WHO, 2015; Oviedo-Trespalacios, & Scott-Parker, 2017). While the overall fatalities from road traffic crashes in the US have decreased, pedestrians fatalities have been on the increase (Lee et al., 2015). Pedestrian facilities such as crosswalk/zebra crossings, pelican crossings, pedestrian walkways and footbridges are constructed to minimize potential pedestrian-vehicle interactions (Ojo et al., 2019). The introduction of footbridges is to ensure pedestrian safety while maintaining the smooth uninterrupted vehicular flow. Thus, the age-old definition of a footbridge or pedestrian overpass is a vertical separation device used to separate pedestrians from road vehicular traffic without risking a road traffic crash (RTC) still holds true (Ribbens, 1996; Hasan,

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& Napiah, 2014).

The decision to or not to use a pedestrian facility, in this case, a footbridge, is largely dependent on pedestrian behaviour and attitude although design type and some enforcement measures may compel its use (Rasanen et al., 2007; Hidalgo-Solórzano et al., 2010; Oviedo-Trespalacios & Scott-Parker, 2017). Research has indicated that proper design of pedestrian facilities improves pedestrian safety and comfort with minimal side-effects on vehicle travel (Handy, 1996; Shriver, 1997; Carnten, et al., 1998). Proper pedestrian facilities also create pedestrian-friendliness and safe environments by grade separation; improve visibility; enhance proper sign communications; and provides assistance to special-need pedestrians.

These notwithstanding, pedestrians may not necessarily use a footbridge or other safe crossing infrastructure for several factors including location and proximity to the crossing situation, and other complex traffic conditions (Rasanen et al., 2007; Hidalgo-Solórzano et al., 2010; Oviedo-Trespalacios & Scott-Parker, 2017). The propensity for unsafe crossing is mainly time-related and is attributed to the need to rush to various destinations. Majanja, (2013) summarized the criteria for footbridge utilization into design features affecting usage, adjoining land-use, roadway geometry, pedestrian safety, convenience, vehicle traffic operation and an alternative safe crossing close to the footbridge. The study assumed that a footbridge will be used when all the criteria are met (Majanja, 2013). The responsibility to provide facilities that encourage and protect pedestrians lies squarely with city managers especially traffic engineers. Hence, the need for policy change to support safe and sustainable mobility in LMICs must always be prioritized (Sisiopiku & Akin, 2003).

The literature is replete with information on the use and non-use of footbridges (Oviedo-Trespalacios, & Scott-Parker, 2017; Hasan and Napiah, 2018; Hasan, et al., 2020). The role of footbridges in pedestrian safety has received less attention in urban transport research and policy in LMICs and Ghana is no exception (Noora et al., 2016; Quansah & Addy, 2021). Therefore, it is important to understand pedestrian mobility behavior to inform policy for pedestrian safety in LMICs especially Ghana (Noora et al., 2016; Heydari et al., 2019). Several studies have addressed similar pedestrian safety issues in other LMICs. Hidalgo-Solórzano et al (2010) adopted a cross-sectional survey to analyse the motives to use and not use footbridges in Mexico City, Mexico. Abojaradeh (2013) evaluated footbridges and pedestrian safety in the Greater Amman Area, Jordan using a questionnaire survey. Hasan and Napiah (2014) assessed design factors for footbridges and the street beneath them, showing how these design factors affect footbridge use. Demiroz et al. (2015) used a video-based study in Turkey, which revealed that almost half of the surveyed pedestrians did not use the footbridges to cross the road. In addition, Hasan and Napiah (2017) investigated the rate of footbridges in Ipoh City, Malaysia using a questionnaire survey. On a Colombian highway, Oviedo-Trespalacios, and Scott-Parker, (2017) investigated the factors influencing the decisions to cross using an intercept survey.

Hassan and Napiah (2018) on the other hand, assessed the perception of pedestrians in Malaysia on the use of footbridges using both observational and questionnaire surveys. Umar et al. (2019) adopted a questionnaire survey to determine the factors influencing the use of footbridges by pedestrians in Kano City, Nigeria. Banerjee and Maurya (2020) determined the factors influencing pedestrian use of footbridges in India using a questionnaire survey. Quite recently, Hasan, Oviedo-Trespalacios and Napiah, (2020) used an intercept survey to understand the factors influencing the use of footbridges in Malaysia.

All these provided empirical evidence on the use and non-use of footbridges in LMICs such as Colombia, Jordan, Malaysia, Mexico, Nigeria, and Turkey. To the best of the knowledge of the authors, only two studies have addressed pedestrian safety at footbridges in Ghana (Noora et al., 2016; Quansah & Addy, 2021). Specifically, Noora et al. (2016) assessed pedestrian adherence to road traffic regulations on the George Walker Bush Highway (N1) in Accra, Ghana. Meanwhile, Quansah and Addy, (2021) investigated the challenges associated with the use of footbridges in Ghana. The two authors called for future research on the crossing behavior of pedestrians at footbridges in Ghana (Noora et al., 2016; Quansah & Addy, 2021).

The increasing number of pedestrian crashes in Accra and Kumasi, Ghana raises concerns and it is largely attributed to the non-availability or when available, non-use of footbridges (Noora et al., 2016). This is because the construction of pedestrian bridges in urban Ghana, is a relatively new phenomenon. In Greater Accra and Greater Kumasi Metropolitan Areas, footbridges appear to be an added-on infrastructure to the road rather than parts of the initial road planning process. This seems, not only to distort pedestrian flow patterns but raises questions about the appropriateness of their use.

Therefore, it is expedient to first ascertain the socio-demographic characteristics of users and non-users of footbridges in Ghana. Further, the paper used structural equation modeling (SEM) to investigate the factors influencing the use and non-use of footbridges in Ghana. An SE model will provide the opportunity to use several criteria especially the t-values (structural coefficients) to assess the goodness of fit (Adedia et al., 2020; 2021). To achieve this, the authors leaned on Oviedo-Trespalacios and Scott-Parker’s (2017) and Hasan, Oviedo-Trespalacios and Napiah’s, (2020) studies in Colombia and Malaysia respectively by intercepting users and non-users of footbridges in Ghana. This method gives a first-hand information as the respondents were approached while using the footbridge or just after jaywalking.

This studies seeks to shed some light on how socio-demographic characteristics including gender, age and level of education influence the use and non-use of footbridges. This will enable city managers to offer tailor-made interventions to improve pedestrian safety in LMICs. This paper will also provide information on footbridge use and non-use to be used by officials of the National Road Safety Authority (NRSA), Motor Transport and Traffic Department (MTTD) of the Ghana Police Service (GPS) and Ghana Highway Authority (GHA) to ensure maximum pedestrian safety along Ghanaian highways with footbridges.

The rest of the manuscript presents the methods and data, results and discussion, conclusion and policy implication, limitations, and further studies.

1.1. Physical factors influencing use and non-use of footbridges

Räsänen et al. (2007) in Ankara, Turkey, revealed that the perception of saving time with the use of a footbridge and frequency of use for a concerned road were significantly related to pedestrian use of footbridges. It was also revealed that being familiar with the Central Business District (CBD) reduced the likelihood of using the footbridge (Räsänen et al., 2007).

Hasan et al. (2020) in Malaysia, noted that a footbridge height and frequency of use were associated with a decrease in the likelihood of utilizing the structure. Being in a hurry was positively associated with crossing at the street level which indicated that time-saving was the main reason for not using the footbridge in a study by Demiroz et al. (2015), who conducted an observational survey in Turkey. Oviedo-Trespalacios and Scott-Parker, (2017) in a direct observational study found that previous experience of pedestrian injuries was a significant factor in determining footbridge use.

Hasan and Napiah (2018) while assessing the perception of Malaysian pedestrians toward the use of footbridges revealed that the existence of an escalator was the most significant factor regarding footbridge use while fear of heights and being in a haste were significant factors associated with non-use in a similar study in Nakhon Ratchasima, Thailand, Sangphong and Siridhara, (2014) factors that influenced urban pedestrians to use footbridges were the number of co-pedestrians, distance between bus-stop and footbridge while for suburban pedestrians, the factors were self-experiencing road traffic crashes, proximity to bus stops, known laws about pedestrians, and number of co-pedestrians.

In a study by Hasan and Napiah, (2017b) conducted a study in Ipoh, Malaysia to rank factors influencing the use of seven footbridges. Their study reported the existence of an escalator, role of parents, existence of fences and barriers, law enforcement, and safety awareness in descending order. Hasan and Napiah (2014) further pointed out that the structure and street characteristics influenced footbridge usage. Hasan and Napiah, (2017) found lack of time to be the greatest determining factor since pedestrians considered the time to ascend, walk along the deck and descend the bridge as time-consuming. According to a Transport Research Board (2012) report, the inherent resistance to climbing hills could explain why pedestrians show reluctance to using an overpass. Soltani (2014) revealed that the reluctance could also be lack of lift or ramp, physical barriers to the use, accident record and general appearance.

1.2. *Influence of socio-demographic characteristics of pedestrians on the use or non-use of footbridges.*

A study by Hełdak et al. (2021), confirmed a significant positive relationship between age and social status on the frequency of footbridge use. Females were seen to use footbridges more than males and children more than adults in a Jordanian study (Abojaradeh, 2013). On the other hand, it has been found by Tanaboriboon and Jing, (1994) that neither age nor gender of pedestrians mattered since people will doubtless avoid a footbridge due to the encumbrances with climbing up and down the stairs, though they assert it could be a major reason for non-use by the elderly and unhealthy people. Rasanen et al. (2007) suggested that use and non-use of footbridges were rather habitual and based on past usage behaviour though the logistic regression model showed usage rate to be influenced by time savings, safety, and familiarity with the area. In Hildago-Solorzano et al. (2010), laziness and effort required to use a footbridge were the most significant reasons behind the facility's non-use. Pedestrian perception was found to be the most deciding factor for the use or non-use of a footbridge (Hasan & Napiah, 2017).

2. Methods and data

2.1. *Study area*

Ghana is an LMIC located in West Africa with a population of about 31million. Ghana is rapidly urbanizing with its administrative, commercial and entertainment activities predominantly concentrated in Accra but gradually spreading out to other cities like Cape Coast, Kumasi, Tamale and Sekondi-Takoradi. Accra, the capital city, has the highest number (16) of footbridges, with Kumasi and Cape Coast having one each. The footbridges in Accra and Kumasi are opened for public use unlike that of Cape Coast which has limited use and is intended for use by students located on opposing sides of the Aggrey Memorial A.M.E school.

Accra is the administrative capital of the Accra Metropolitan Assembly (AMA) which is one of 10 districts that make up the Greater Accra Metropolitan Area (GAMA) (see Fig. 1). The estimated population of GAMA is 4.3 million and is expected to double in 20 years. Kumasi is the nucleus of an emerging metropolitan region (often referred to as Greater Kumasi Metropolitan Area or GKMA) that comprises the old city and six adjoining districts—Ejisu-Juabeng, Bosomtwe, Kwabre East, Afigya Kwabre, Atwima Nwabiagya, and Atwima Kwanwoma.

The GKMA covers an area of approximately 2,746 km^2 and has a combined population of 2,564,120 in 2010, 79% of which reside in the Kumasi Metropolis (see Fig. 2). Six footbridges comprising Accra Mall, Kaneshie (the one very close to the market), Mallam, Lapaz, Kwashieman, Madina were selected because of their heavy pedestrian traffic. The only footbridge in Kumasi (Tech Junction), was also surveyed (see Figs. 1 and 2). The other in the Cape Coast area was also left out because it serves only a cordoned student population. The selected footbridges are in areas characterized by many traffic generators such as schools, shopping malls, bus stops, office complexes, restaurants etc. which

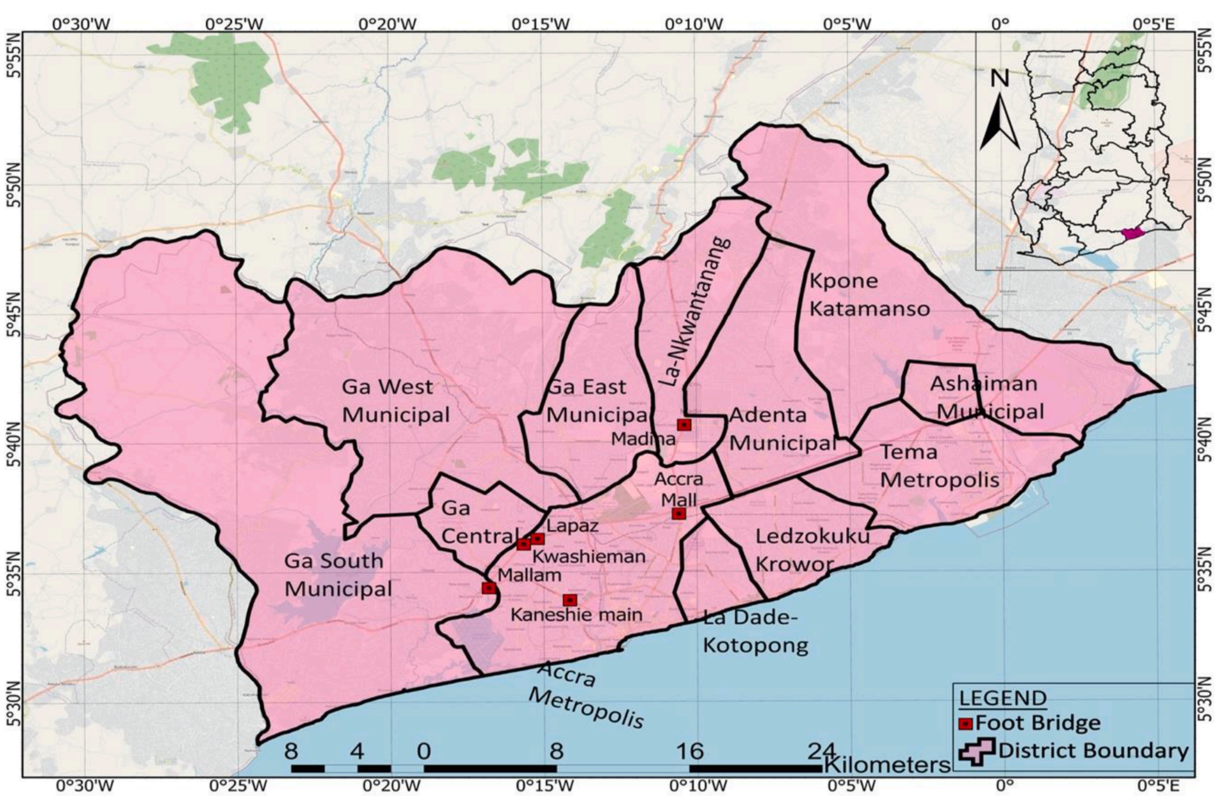

Fig. 1. Map showing the location of six footbridges in GAMA. Source: GIS Unit of the Department of Geography and Regional Planning, UCC.

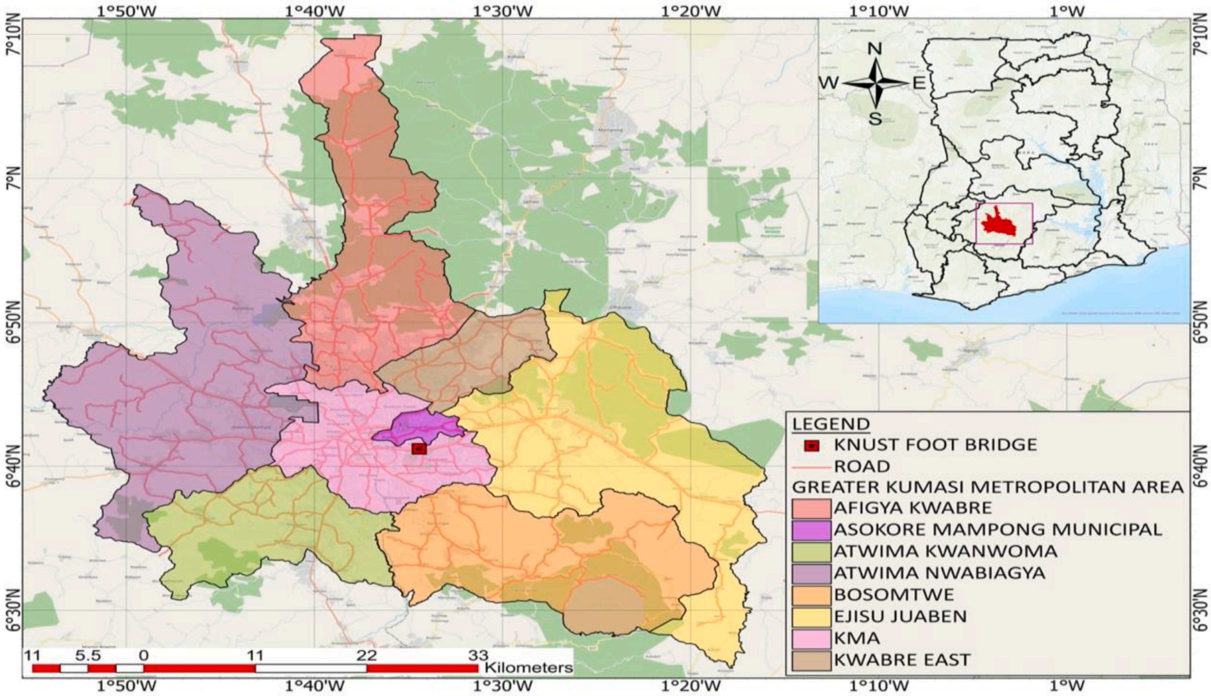

Fig. 2. Map showing the location of KNUST footbridge in GKMA Source: GIS Unit of the Department of Geography and Regional Planning, UCC.

contribute to the prevailing economic, educational, and social activities in the locations. Characteristics of all selected footbridges and adjoining roads are given in Table 1.

2.2. Research design

The study is a descriptive-explanatory research design that seeks to provide ample information on a phenomenon demanding extensive research.

2.3. Pilot study

A pilot study was conducted between 31st May-1st June 2021 at Shiashie footbridge, Accra. A systematic sampling technique was planned for the interview schedule by purposively selecting every 5th user and non-user respectively. This posed serious challenges as most selected respondents declined to participate in the exercise due to time constraints and research fatigue, hence the choice of the accidental sampling technique. At least 20 interview schedules were administered by each of the two research assistants assigned to the footbridge from 7:00am-9:00am, 11:00am-1:00 pm, and 3:00 pm-5:00 pm.

Information gathered from the interviews on socio-demographic characteristics included gender, age, occupation, and academic qualification. Additional information collected included frequency of use and non-use and familiarity of the neighbourhood. The entire cycle time for administering one interview schedule was approximately five minutes excluding the time spent soliciting for the next respondent. The interviews were conducted at the footbridge or in the vicinity of the footbridges.

Table 1
Characteristics of Selected footbridges.

	Footbridge Characteristics							
Bridge location	Year of construction	Height (m)	Length (m)	Width (m)	Number of stairways	Number of steps	Presence of hawkers/beggars/ preachers	Disability-friendly
Accra Mall	2015	6	26	4	2	38	No	Yes
Kaneshie		5.5	30	4	4		Yes	No
Lapaz	2012	5.5	50	4	2		Yes	No
Mallam	2015	6	30	4	2	38	Yes	Yes
Madina	2012–2019	6	62	4	4		Yes	Yes
Kwashieman	2012	5.5	50	4	4		Yes	No
KNUST	2015	6	26	4	2	38	Yes	Yes

Characteristics of the street beneath the bridge					
Bridge location	Width (m)	Direction	No of lanes	Presence of traffic light	Distance to the traffic light (m)
Accra Mall	4	2	6	No	–
Kaneshie	4	3	6	Yes	350 m to the West
Lapaz	4	2	4	Yes	200 m to the West – 250 to the East
Mallam	4	2	4	Yes	150 m to the West
Madina	4	2	4	Yes	100 m to the North
Kwashieman	4	2	4	Yes	200 m to the West
KNUST	4	2	4	Yes (Pelican Crossing)	300 m to the south

Source: Ghana Highway Authority (2021); Field survey, 2021) * not available.
KNUST-Kwame Nkrumah University of Science and Technology.

2.4. Research instrument

The challenges observed with the interview schedule during the pilot study led the authors to divide the schedule into three sections. The first section, A, dealt with the socio-demographic characteristics (such as gender, age, academic qualification, occupation) of respondents, formal education/training on footbridge use, considerable walking distance to the footbridge (100–150 m), familiarity of the neighbourhood, and previous involvement in using a footbridge.

The next section, B, addressed questions targeted at footbridge users and included frequency of and reasons for using the footbridge. The last section, C, also focused on non-users and comprised time and frequency of crossing the road/not using the footbridges, and reasons for non-usage.

2.5. Ethical issues

Ethical clearance was obtained from the Committee on Human Research Publication and Ethics ((CHRPE/AP/174/21), Kwame Nkrumah University of Science and Technology (KNUST). We also obtained informed consent from pedestrians who were interviewed and assured their confidentiality.

2.6. Sample frame and size

Results of the pilot study indicated that at least 20 users and non-users could be interviewed daily by each research assistant (RA). Therefore, each RA was tasked to interview at least 140 users and non-users during the 7-day survey. Hence the sample size of 1,820.

2.7. Sampling technique

Accidental sampling technique was used in the selection of the respondents since they were in transit and only willing respondents were interviewed.

2.8. Data collection

Thirteen research assistants were recruited for the data collection. Two research assistants were stationed at Mallam, Lapaz, Accra Mall, Madina, and KNUST footbridges with one interviewing users on the footbridge and the other attending to non-users. However, only one research assistant observed users at the Kaneshie footbridge (the one very close to the VIP station). The nature of the Kaneshie footbridge does not give room to jaywalkers as the median of the road has been fenced. The observations of the non-users were made in the vicinity of the footbridges (100 m-150 m radius).

The intercept survey was conducted from Monday 7th-Sunday 13th June 2021 within three time periods (7:00am-9:00am, 11:00am-1:00 pm, and 3:00 pm-5:00 pm) daily. Pedestrians mostly leave for their daily activities from 7:00am-9:00am and return home from 3:00 pm-5:00 pm. Hence the choice of these periods for the project (Yankson, et al., 2020; Ojo, 2018; Ojo, et al., 2019), but the 11:00am-1:00 pm was chosen to capture the off-peak period.

2.9. COVID-19 protocols

All RAs were given disposable face masks with hand sanitizers and were instructed to stay at a considerable distance from the interviewees. Only interviewees with nose masks were interviewed as part of the COVID-19 protocols.

2.10. Data analysis

The data from the interview schedule was analyzed using SPSS v.21 with thematic analysis of all open-ended questions presented in tables and graphs alongside their frequencies and percentages. The relationships between dependent and independent variables were assessed using Structural Equation Modelling (SEM). SEM (also referred to as causal modelling), is an aggregation of varied statistical techniques that better define sets of relationships between one or more independent or dependent variables, either continuous or discrete, to be investigated (Ullman and Bentler, 2013). This was employed to enable the authors better explain the complexities of all factors influencing footbridge use and non-use in Ghana.

3. Results

3.1. Demographics of respondents

As shown in Table 2, more than half (56.5%, 55.8%) of the respondents were males and aged > 25 years respectively. More than a third (35.0%) of the respondents were students. Further, more than two-thirds (67.8%) of the respondents were users of the footbridges (Table 2). The largest single group of respondents were passers-by (28.9%), but most (71.1%) had been residents in the area for variable periods of time. Most had no formal training/education (83.6%) on footbridge usage. Almost half of the respondents (47.5%) indicated that considerable walking distance was 51 m-100 m to a footbridge and those who had been involved in a pedestrian crash before were 3.8% (Table 2).

3.2. Cross-tabulation of demographics and status of pedestrian

As indicated in Table 2, more males were among non-users (59.6%) than users (55.1%) unlike their female cohorts with more users (44.9%) than non-users (40.4%). Majority of those aged 18–25 years were non-users (48.6%) than users (41.0%). Those with secondary education were in the majority as either users (36.7%) or non-users (43.2%). Students and passers-by were also in the majority for both users (37.1%, 27.1%) and non-users (31.0%, 29.8%) respectively. Most of those who had previously been involved in a pedestrian crash used the footbridge the more (see Table 2). With the exception of gender and the length of stay, all variables including age group, education, frequency of use of footbridges, previous involvement in a pedestrian crash, formal education on the use of footbridges were found to have a significant relationship with the use and non-use of footbridges (Table 2).

3.3. Modeling the use and non-use of footbridges

To model many relationships in a dataset, structural equation modelling (SEM) is useful, and fit indices are used to assess SE models (Adedia et al., 2020; 2021). The SE model as shown in Table 3 fits the data accurately by reporting Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI) and Tucker-Lewis Index (TLI) values of 0.995, 1.000, 0.998, and 0.986, respectively. The model also reported Standardized Root Mean Residual (SRMR), Root Mean Residual (RMR) and Root Mean Square Error of Approximation (RMSEA) values of 0.014, 0.002 and 0.025 respectively. The fit indices fall within the acceptable cut-off values indicating the goodness of the model.Table 4..

The chi-square test in table 3 indicates a statistically significance level at $p < 0.05$. Users of footbridges were more likely to be involved in a pedestrian crash at p-value < 0.01 (see Fig. 3 and Table 3). Formal education or training (p-value < 0.01) and age (p-value < 0.01) were significant determinants of the use of footbridges. Those who had formal education were more likely to use footbridges while elderly people were less likely to use them. Frequency of use of footbridges (p-value < 0.01) also affected the usage status, moreover, most users use it frequently. How often one crosses stretch road (p-value < 0.01) and walking distance (p-value < 0.01) affected the frequency of use of footbridges. Males and those who walk long distances were less likely to use footbridges frequently while, those who often cross the stretch road mostly

Table 2
Crosstabulation of socio-demographic characteristics and status of pedestrians.

Socio-demographic characteristics		Status of pedestrian Non-user F (%)	User F (%)	Total F (%)	P-value <0.05
		597 (32.2)	1255 (57.8)	1852 (100)	
Gender	Male	356 (59.6)	691 (55.1)	1047 (56.5)	0.06
	Female	241 (40.4)	564 (44.9)	805 (43.5)	
Age group	<18 years	51 (8.5)	179 (0.3)	230 (12.4)	
	18–25 years	290 (48.6)	514 (41.0)	804 (43.4)	0.00
	26–50 years	207 (34.7)	469 (37.4)	676 (36.5)	
	>50 years	49 (8.2)	93 (7.4)	142 (7.7)	
Academic qualification	Basic	156 (26.1)	279 (22.2)	435 (23.5)	
	Secondary	258 (43.2)	461 (36.7)	719 (38.8)	
	Tertiary	173 (29.0)	428 (34.1)	601 (32.5)	0.00
	Post-tertiary	10 (1.7)	87 (6.9)	97 (5.2)	
Occupation	Students	185 (31.0)	466 (37.1)	651 (35.2)	
	Trader/ business	181 (30.3)	254 (20.2)	435 (23.5)	
	Government worker	26 (4.4)	150 (12.0)	176 (9.5)	0.00
	Company worker	76 (12.7)	175 (13.9)	251 (13.6)	
	Self-employed	80 (13.4)	182 (14.5)	262 (14.1)	
	Unemployed	49 (8.2)	28 (2.2)	77 (4.1)	
Length of stay in the neighbourhood	A passer-by	162 (27.1)	374 (29.8)	536 (28.9)	
	<6months	59 (9.9)	83 (6.6)	142 (7.7)	
	6 months-1 Year	106 (17.8)	195 (15.5)	301 (16.3)	
	1–5 years	153 (25.6)	362 (28.8)	515 (27.8)	0.05
	>5years	117 (19.6)	241 (19.2)	358 (19.3)	
Formal education/ training on footbridge use	No	560 (93.8)	1038 (82.7)	1598 (86.3)	0.00
	Yes	37 (6.2)	217 (27.3)	254 (13.7)	
Considerable walking distance to the footbridge	0–50 *m*	71 (11.9)	453 (36.1)	524 (28.3)	
	51–100 *m*	348 (58.3)	532 (42.4)	880 (47.5)	
	101–150 *m*	142 (23.8)	154 (12.3)	296 (16.0)	0.00
	>150	36 (6.0)	116 (9.2)	152 (8.2)	
Frequency of footbridge use	No	529 (88.6)	162 (12.9)	691 (37.3)	0.00
	Yes	68 (11.4)	1093 (87.1)	1161 (62.7)	
Previous involvement in pedestrian crashes	No	587 (98.3)	1195 (95.2)	1782 (96.2)	0.00
	Yes	10 (1.7)	60 (4.8)	70 (3.8)	
How often do you cross this stretch of road in this location	First timer	51 (8.5)	59 (4.7)	110 (5.9)	
	Once a month	78 (13.1)	56 (4.5)	134 (7.2)	
					0.00

Table 2 (*continued*)

Socio-demographic characteristics		Status of pedestrian Non-user F (%)	User F (%)	Total F (%)	P-value <0.05
	A couple of times a month	74 (12.4)	109 (8.7)	183 (9.9)	
	Weekly	30 (5.0)	163 (13.0)	193 (10.4)	
	Several times a week	250 (41.9)	468 (37.3)	718 (38.8)	
	Every working day	114 (19.1)	400 (31.9)	514 (27.8)	

*significant p-value < 0.05.

used footbridges frequently. However, gender was not statistically significant at $p > 0.05$.

Frequency of use of footbridges had the highest effect (0.74) on usage status, implying how frequently people use footbridges determined their status. How often one crosses stretch of the road had the highest effect (0.24) on how frequently the user uses the footbridges and was followed by walking distance (-0.19), before gender (-0.09).

To prevent jaywalkers, a billboard is mounted at Madina Junction as shown in Fig. 4. Figs. 5-7 show research assistants interviewing pedestrians at the study sites. Non-users were asked why they did not want to use the footbridges.

Fig. 8 indicates that most (79.4%, 65.0%) of the pedestrians who did not use footbridges felt that the footbridges were located too far away and that it was tiring using the footbridge respectively. As shown in Fig. 9, most of the pedestrians who did not use footbridges perceived not using the footbridge to be very dangerous (34.8%) or dangerous (33.0%).

4. Discussion

The crux of this study was to ascertain the socio-demographic characteristics of the users and non-users of footbridges in Ghana and to model the factors influencing this use or non-use with SEM using quantitative data from interview schedules obtained from pedestrians. An accidental sampling technique was used to select pedestrians at seven footbridge locations: six in GAMA and one in GKMA. Data was collected in the second week of June during 7:00am-9:00am, 11:00am-1:00 pm and 3:00 pm-5:00 pm.

It was revealed in the study that more males were non-users of the footbridges than females. It is not surprising that males are in the majority as non-users of footbridges because they are generally risk takers when compared to their female cohorts (Agyemang et al., 2021). Female pedestrians usually take less risks in using pedestrian facilities and as such are less violators of road traffic regulations (Hasan et al., 2020).

As evident in the study many non-users were 18–25 years old. Notably, this age bracket always exhibits risky behaviors and as such being adventurous when it comes to road traffic violations. This phenomenon is not only peculiar to LMICs but also high-income countries (Hildago-Solorzano et al., 2010; Ojo et al., 2019). It was also found that residents were in the majority for both footbridge users and non-users. This is similar to another study in Ghana (Noora et al., 2016) where residents were the main pedestrians accessing business centres, school, workplace, or social centres.

The study found that females who were > 25 years old with secondary education, were more likely to use a footbridge than other age brackets in Ghana like similar studies in other LMICs such as Jordan (Abojaradeh, 2013). In other studies, in China, Mexico and Turkey however, no relationship was found between age and gender with footbridge use (Tanaboriboon and Jing, 1994; Rasanen et al., 2007; Hildago-Solorzano et al., 2010). This may be in line with the fact that

Table 3
Coefficient of the SEM model.

	Walking Distance	Length of Stay	Gender	Usage Status	Frequency use Footbridge	Age	Formal Education/ training on footbridges	How often cross Stretch road	Involvement in Pedestrian crash
Walking Distance	–	0.02	−0.02	–	−0.19	0.00	−0.03	−0.06	–
Length of stay	0.02	–	−0.02	0.01	0.07	0.11	0.00	0.25	–
Gender	−0.02	−0.02	–	0.01	0.09	0.01	0.05	−0.01	–
Usage Status	–	0.01	0.01	–	0.74	−0.06	0.14	0.00	0.09
Freq. use Footbridge	−0.19	0.07	0.09	0.74	–	0.03	0.01	0.24	–
Age	0.00	0.11	0.01	−0.06	0.03	–	−0.04	0.10	–
Formal Education	−0.03	0.00	0.05	0.14	0.01	−0.04	–	−0.02	–
How often cross Stretch road	−0.06	0.25	−0.01	0.00	0.24	0.10	−0.02	–	–
Involve. In Pedestrian crash	–	–	–	0.09	–	–	–	–	–

Note: Standardized coefficients close to ± 1, signifies strong relationships or effects.

Table 4
Fit indices for Model.

RMSEA	SRMR	RMR	CFI	GFI	AGFI	TLI
0.025	0.014	0.002	0.995	1.000	0.998	0.986

females tend to be more safety inclined and obedient to rules than their male counterparts. This trend could also result from the success story of road safety education and campaigns in basic schools organized by the NRSA over the last 10 years.

Notably, many pedestrians who were positively inclined to footbridge use had no formal training or knowledge on footbridge usage while a minute fraction had been involved in a pedestrian crash before the survey. Many student pedestrians could explain why they preferred to use the footbridge since their education places them in a better position to perceive the risks and dangers associated with non-use though they may not have had any prior training on footbridge use per se.

Prior involvement in a pedestrian crash was described by Räsänen et al. (2007) as "habitual" and concluded that use and non-use of footbridges were more habitual and based on past behaviours. Involvement in a prior pedestrian crash also contributed positively to footbridge use, as it is said, "experience is the best teacher"! People learn more and better from personal experiences than from being merely taught or trained.

Most pedestrians indicated that the distance from their origins to the footbridge locations was considerably long and posed a huge discouragement and disincentive to its use. This is in harmony with studies in Malaysia, Turkey, Thailand, and the USA which cited long distance as a factor that mostly influenced a footbridge non-use (Sisiopiku and Akin, 2003; Rasanen et al., 2007; Sangphong and Sridhara, 2014; Demiroz et al., 2015; Oviedo-Trespalacios and Scott-Parker, 2017; Hasan and Napiah, 2017; Hassan et al., 2020). When people are in a hurry to get to their destinations, they are willing to cut corners and use any route be it safe or not. Thus, the distance to adjoining facilities must be critically considered in the design of pedestrian facilities to serve as an incentive for use.

As shown in the findings police officers are positioned at vantage

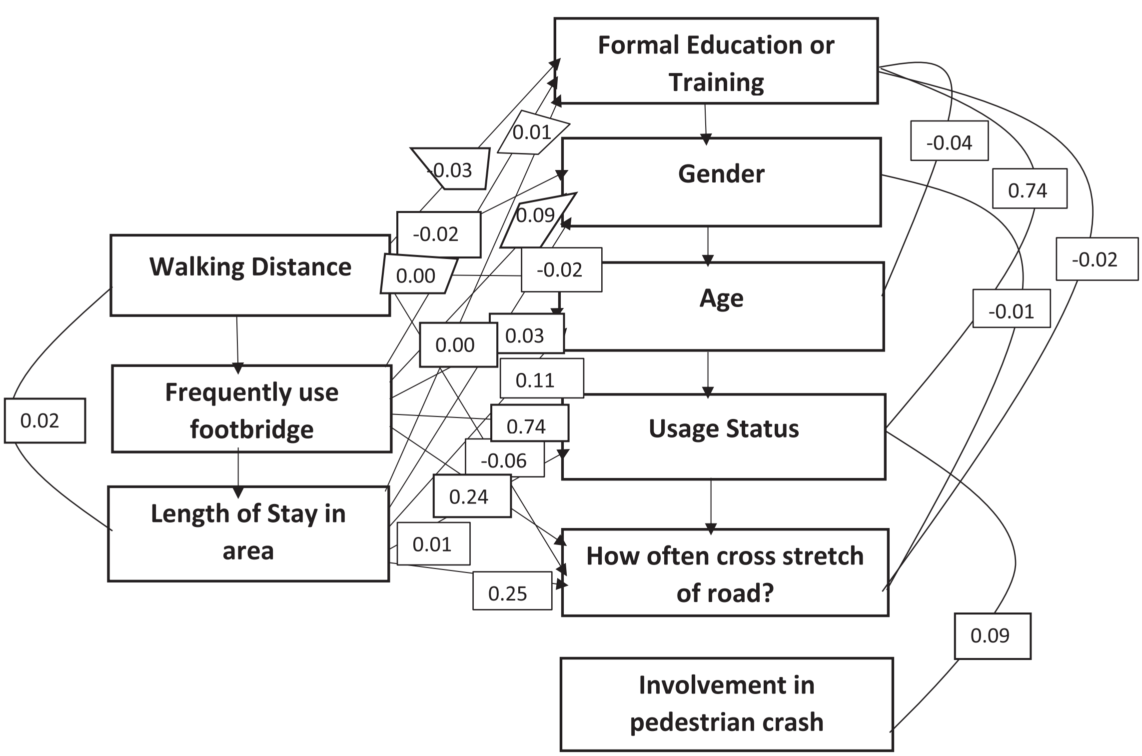

Fig. 3. SEM Model.

Fig. 4. Police officer to ward off jaywalkers.

Fig. 6. Accra Mall footbridge barring riding.

Fig. 5. Interviewing a non-user at Accra Mall and billboard on footbridge use at Madina.

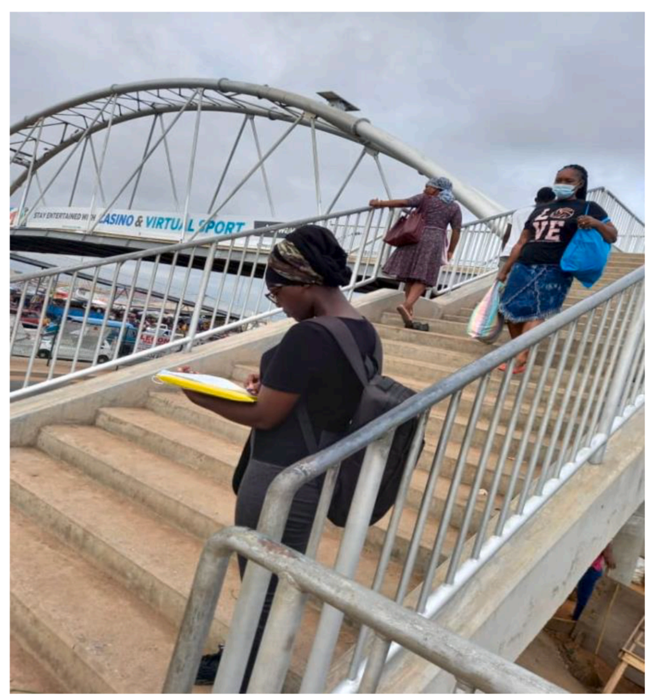

Fig. 7. A researcher at Mallam footbridge.

points to force pedestrians to use the footbridges though there are still recalcitrant jaywalkers who are severely dealt with when caught. Yet, jaywalking persists at these locations in Ghana (Noora et al., 2016).

5. Conclusion and policy implication

In the present study, data from 1,852 users and non-users of pedestrian footbridges in Greater Accra and Kumasi Metropolitan Areas, Ghana were analyzed. The purpose was to assess factors influencing the use and non-use of footbridges in Ghana. Data extracted for the analysis were socio-demographic characteristics of respondents and reasons for footbridge use and non-use in Ghana.

The socio-demographic characteristics, footbridge usage status, and SEM have been comprehensively discussed. Most pedestrians were male, students and single, users of footbridges, and passers-by with no formal training/education on footbridge usage. It was indicated that more males were non-users than users, those with secondary education, and those who had been involved in a previous pedestrian crash used footbridges the most. SEM concludes that the following factors influence the use of footbridges in Ghana: gender, age, training on footbridge use, frequency of use, length of stay in the neighborhood, walking distance

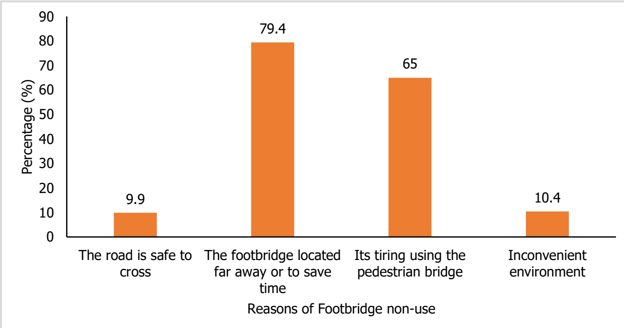

Fig. 8. Reasons of pedestrian footbridge non-use.

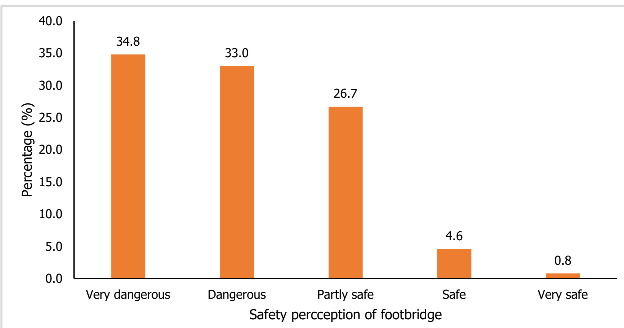

Fig. 9. Pedestrians' safety perception of footbridge.

and how often one crosses the road and previous involvement in a crash.

City managers in LMICs including Ghana, Jordan, Nigeria, and Malaysia should consider the factors influencing the use and non-use of footbridges to reduce the incidence of RTCs emanating from pedestrian-vehicular interactions. Officials of the NRSA in Ghana should increase the tempo of pedestrian safety education in the study area especially with regards to the use of footbridges. Notably, the presence of officials of MTTD of the Ghana Police Service can help improve footbridge use in Ghana. Jaywalkers will be afraid of possible arrest and prosecution by the officials of the MTTD of the Ghana Police Service. This will act as a deterrent to errant pedestrians. Officials of the Ghana Highways Authority should increase the number of footbridges and make sure that sufficient numbers are placed near traffic generators (such as markets, schools, supermarkets etc.) along the highways.

6. Limitations and further studies

Although this study has provided ample information on the use and non-use of footbridges in Ghana, it fails to address how pedestrians use or do not use them in Ghana. Future studies can address this phenomenon. This can be done by using an observational study against the use of an intercept study in the current paper. It is better to ascertain the behaviour of pedestrians in natural settings.

There is the need to look at how pedestrians at each of the footbridges use or do not use it. The characteristics of each footbridge may posit different results as indicated in Table 1. Some of the footbridges especially the one at Kaneshie has a barrier preventing jaywalkers. Similarly, there are police officers stationed at the footbridge at Madina. Hence, the incidence of jaywalkers will be minimal.

There are several variables (such as day of the week and time of the day) that may influence the use and non-use of footbridges. Therefore, future studies can use either an observational or intercept study to investigate the effect of these timing factors.

Lastly, the current study considered how pedestrians generally use or do not use footbridges in Ghana. Future studies can specifically assess how school children use or do not use footbridges in Ghana. Moreover, this study did not determine if pedestrians were aware of the Road Traffic Law banning jaywalking. Future study can as well investigate that.

CRediT authorship contribution statement

Thomas Kolawole Ojo: Conceptualization, Writing – original draft. **Anthony Baffour Appiah:** Project administration, Resources, Investigation. **Abena Obiri-Yeboah:** Writing – review & editing. **Atinuke Olusola Adebanji:** Formal analysis, Data curation. **Peter Donkor:** Supervision, Project administration. **Charles Mock:** Writing – review & editing, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data set

The data set can be made available upon request. All the variables investigated are in Tables 2 and 3.

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