EASR

Engineering and Applied Science Research

https://www.tci-thaijo.org/index.php/easr/index

Published by the Faculty of Engineering, Khon Kaen University, Thailand

Structural equation modeling of the factors influencing pedestrians' overpass utilization preference: A case study in Iligan City, Philippines

Joel G. Opon*[1, 2], Frexie L. Unde[2], Kyle Adrian A. Oliva[2], Augustus Nicko T. Bas[2], Raquel O. Masalig[2], Cheery May S. Florendo[2], Florife D. Liwanag[2] and Rengie P. Bagares[2]

[1]Center for Structural Engineering and Informatics, MSU – Iligan Institute of Technology, Philippines
[2]Department of Civil Engineering and Technology, College of Engineering, MSU – Iligan Institute of Technology, Philippines

Received 12 January 2024
Revised 8 May 2024
Accepted 20 May 2024

Abstract

Overpasses are constructed because they allow continuous passage of pedestrians without disturbing the flow of vehicles. However, research from developing countries along with the anecdotal evidence from the study location revealed that generally most pedestrians prefer not using overpasses in crossing roads, rendering them inefficient and causing safety concerns. As such, this paper examines the factors - both observable and latent - influencing pedestrians' overpass utilization preference. The study was situated in Iligan City, Philippines, wherein four overpasses in the city were investigated by conducting on-site observations and questionnaire surveys. The data collected were analyzed using a combination of multiple linear regression (MLR), exploratory factor analysis (EFA), and structural equation modeling (SEM). On-site pedestrian traffic count revealed that the overpasses in Iligan City are generally ineffective, with only 38.42% average utilization rate. The MLR revealed three observable contributing factors that may affect pedestrian overpass crossing choice: having a driver's license, the overpass width, and the overpass span. EFA and SEM were able to identify safety, convenience, facility condition, and security as the latent factors having a positive direct influence on the preference of pedestrians overpass utilization. These results are instrumental at determining areas of concern relating to overpass design and improvements to increase the utilization rates of the overpass facilities in the city.

Keywords: Overpass, Utilization, Latent factors, Exploratory factor analysis, Structural equation modeling

1. Introduction

The steady rise in vehicle ownership is a major concern with regards to road safety, as this could lead to an increase in traffic-related accidents. This road safety concern can be exacerbated as cities grow in size and population resulting from continuous urbanization and modernization coupled with the lack of discipline among drivers and pedestrians and the lagging implementation of traffic safety infrastructure [1]. Vehicular accidents involving pedestrians remains a serious concern in developed and developing countries [2]. As an example, the European Union reported an average of about 20% pedestrian fatalities in traffic accidents [3], while in Hong Kong this statistic is about 60% [2]. The number of traffic accidents involving pedestrians represents 22% of world traffic data [4]. However, developing countries share the greatest burden of road traffic fatalities involving pedestrian crashes [5].

Most pedestrian-related traffic accidents are caused by pedestrians who cross the roads and/or highways illegally [6, 7]. Crossing highways, however, have since become increasingly difficult for pedestrians due to issues with accessibility of crossing facilities. In the Philippines, for example, the need for safe pedestrian crossings is vital, as some highways now have more than two lanes. The increase in road width and number also increases the accident risk for pedestrians who need to cross the road to reach their destination as found by Obinguar and Iryo-Asano [5]. As such, overpasses are installed in select locations to provide safe pedestrian crossings. To cite a local example, in Iligan City, Philippines, a total of five serviceable overpasses provide safe pedestrian traffic for the city. Within the city's boundaries are five malls, 20 schools, two public transport terminals, and a multitude of small- and large-scale business establishments that envelop the majority of pedestrian movements. Some of these establishments are adjacent to the busy roads and highways of the city, hence the need for overpass infrastructures.

Although the five overpasses in Iligan City have been in service for years, there is a significant issue on the frequency with which these facilities are used by the public. Instead of using these overpasses, most pedestrians are observed to cross the street illegally or may sometimes prefer the pedestrian lanes situated farther away from the overpass. This unwillingness of some pedestrians to use overpasses is an issue that needs to be examined thoroughly, as the extant literatures related to roadside accident prevention suggest overpasses as the most effective option to ensure safety for the crossing pedestrians [6, 8]. Moreover, the recent police records from the city highlight a concerning rate of pedestrian-related accidents occurring due to illegal crossings underneath the overpasses. In the last month of 2023 alone, there were at least 20 recorded incidents.

*Corresponding author.
Email address: joel.opon@g.msuiit.edu.ph
doi: 10.14456/easr.2024.45

Early studies have investigated the factors that affect the decisions of pedestrians on where to cross along the road. Results from some of these studies show that these usually involve trade-offs between safety and convenience [9, 10]. If pedestrians prioritize safety, there is a high probability that they are going to choose the available pedestrian crossing facilities instead of illegally crossing the streets. On the other hand, if convenience is more favored, jaywalking is more likely to happen. This effect is compounded by the fact that pedestrians are going to have to "detour" and follow the route dictated by the crossing facilities rather than crossing anywhere or anytime they want [11]. Provisions of closed-circuit television (CCTV) cameras, security personnel, and proper lighting also have immediate influences towards the pedestrians' choice of crossing facility [12].

Identifying crucial elements relevant to overpass utilization such as safety, security, and connectivity helps academics, planners, and legislators build a better planned pedestrian-friendly infrastructure [12]. However, there remains a dearth of research on in this respect in the context of the Philippines. Investigating pedestrian behavior is a significant undertaking not only to ensure pedestrian safety but also to ensuring an efficient implementation of safety rules and regulations. Evidence suggests that theory- based interventions relevant to overpass utilization efficiency are much more effective than non-theory-based ones [13]. This paper, therefore, presents and in-depth study on the factors that influences pedestrians' preference in safely crossing highways or roads, particularly with regards to the use of overpasses in Iligan City, Philippines. The paper presents the application of structural equation modeling as a quantitative approach at determining the latent factors that directly influences pedestrians' decision on overpass utilization preference. This could provide insights for future design consideration to facilitate the effective utilization of pedestrian crossing infrastructures, curbing accidents due to illegal crossings.

2. Factors influencing pedestrian behavior

Truong et al. [8] highlight that pedestrian overpass usage varies significantly between 35.9% and 96.5%. This variation could be due to several factors influencing pedestrian crossing behavior including road and traffic conditions and human factors. For example, Sheykhfard and Haghighi [14], showed that factors related to roads, vehicles, humans, and the environment influencing pedestrian safety. Most pedestrians have been found to prefer utilizing crosswalks even though crosswalks are more dangerous than overpasses and pedestrian bridges [15]. Many vehicle crashes involving pedestrians are caused by pedestrians taking risks [16]. Mutto et al. [17], as an example, found that after the construction of overpasses on major highways in Kampala, Uganda, there were even more traffic accidents and pedestrian injuries but with fewer fatalities.

Overpasses are typically designed with the road and the vehicles in mind rather than prioritizing human needs [18]. Sangphong and Siridhara [19] support this argument and suggest that authorities must pay attention to building overpasses that serve the real needs of pedestrians and initiate awareness programs on law and safety, encouraging pedestrians to use these facilities. Hasan and Napiah [18] also found that there is weakness of law enforcement in the field of safety regarding overpass use. In other words, design and engineering play a critical role at indirectly influencing pedestrians to prioritize overpasses as their main crossing facility. Nevertheless, a lot of other factors remains to be addressed in the context of underutilization of overpasses.

Multiple studies have investigated specific factors that affect pedestrian crossing behavior at overpass locations. For example, using binary logit model, Wu et al. [6] pinpoint gender, age, career, education level, license, detour wishes, detour distance, and crossing time as factors affecting pedestrians' overpass utilization. Alver and Onelcin [20] similarly found that gender, age, vehicle position, and items carried may affect pedestrian overpass crossing behavior. Mutto et al. [17] highlights that adult males are the least likely to utilize an overpass. Their findings also show that pedestrians were more likely to be injured during slow traffic flows. The study by Banerjee et al. [12] also supports similar findings, stating that gender and age have a significant impact on the choice of using an overpass by pedestrians. Further, the other factors affecting pedestrian preference towards using the overpass also include safety and security, walking environment, frequency of daily use, comfort, location type, length of travel, stairway dimensions, and the reduced walkable width.

Al Bargi and Daniel [21] determined vehicle speed, pedestrian age and gender, and presence of baggage as among the variables that had a direct effect on pedestrians' decision on using various crossing facilities. According to Rankavat and Tiwari [10], convenience and safety perceptions are significant for the use of facilities at locations with an overpass, which contradicts the conclusions of Mutto et al. [17]. Results from their study conclude that convenience perception is statistically significant in a pedestrian's preference for pedestrian lanes and that usage of overpasses decreases with age. Similarly, Yanfeng et al. [22] state that pedestrian attraction sites present along both sides of the road impact the pedestrians' crossing behavior, followed by crossing time characteristics, age, and the number of pedestrians waiting to cross the road. Data from the study of Bandara and Hewawasam [23] show that 'self-enforcement features' are the most influencing factor for the effectiveness of overpasses while 'attractiveness' being the least. The study also identified the relationships among the contributing factors, which are: trip purpose and location, location and time, trip purpose and time, convenience and comfort, comfort and personal safety.

A qualitative study on the perceptions about crossing facilities by Anciaes and Jones [24] found that trip purpose, perceptions about local traffic, and fear of crime (primarily focused on specific time of the day) explain pedestrian aversion of overpasses. The same study also included pedestrian disability as one of its observable variables. Truong et al. [8] found that overpass usage decreased with taller overpasses, but increased with wider overpasses. Likewise, gender, weather, and illegal crossing speed were also mentioned as having an effect towards overpass use. Shoabjareh et al. [16] studied the relationship between pedestrian behavioral category and pedestrian demographic data, safety and security perceptions, and similar factors that have been mentioned previously. Peters et al. [25] studied seven pedestrian characteristics (i.e., gender, location, pedestrian arrival, pedestrian position at the beginning of the walk, time of day, baggage handling, and walking in groups) on their effect towards pedestrian behavior and revealed statistical significance for four factors: gender, pedestrian arrival, time of day, and walking in groups. A study conducted by Hełdak et al. [26] noted that, after the construction of roofing for the overpass in Black Sea Coastal Highway, Trabzon, Turkey, public attention on the functionality and safety of using the overpass increased. However, this study did not assess whether this had an effect towards the crossing preference of pedestrians. Overall, extant literature suggest numerous factors (both directly observable and latent factors) affecting pedestrian behavior on overpass utilization, which is summarized in Table 1. These factors were used as basis in crafting the research design and were instrumental for the structural equation modeling analysis.

Table 1 Summary of factors and relevant sources

Factors	Source Literature
Demographic Related factors including gender, age, occupation, educational level, having driver's license, and having disability.	Wu et al. [6]; Truong et al. [8]; Banerjee et al. [12]; Mutto et al. [17]; Alver and Onelcin [20]; Al Bargi and Daniel [21]; Yanfeng et al. [22]; Peters et al. [25]
Behavior and Norms Related to factors including perceived social pressure, frequency of use, group size, weather, and daytime/nighttime use preference.	Banerjee et al. [12]; Yanfeng et al. [22]; Peters et al. [25]
Convenience Related to factors including items carrying, in a hurry, target destination, detour distance, and crossing time.	Wu et al. [6]; Rankavat and Tiwari [10]; Alver and Onelcin [20]; Al Bargi and Daniel [21]; Anciaes and Jones [24]; Peters et al. [25]
Safety Related to factors including crossing with a child, elderly, or person with disability, perceived crash risk, enforcement of laws, vehicle speed, and vehicle position,	Rankavat and Tiwari [10]; Sheykhfard and Haghighi [14]; Shoabjareh et al. [16]; Hasan and Napiah [18]; Alver and Onelcin [20]; Anciaes and Jones [24]; Peters et al. [25]
Security Related to fear of crime.	Shoabjareh et al. [16]; Anciaes and Jones [24]
Physical Attributes of Overpass Related to factors including number of lanes of road, stairway width, self-enforcement features, and height of overpass.	Truong et al. [8]; Sheykhfard and Haghighi [14]; Bandara and Hewawasam [23]; Hełdak et al. [26]

3. Methodology

3.1 Research design

The workflow of the study is shown Figure 1, which starts with the selection of overpasses, followed by measuring the physical attributes of overpasses, then a survey of pedestrian and vehicle traffic counts were conducted to determine the utilization rate, and survey of the pedestrians' willingness to use overpasses using questionnaire. Data analyses and modeling were performed thereafter.

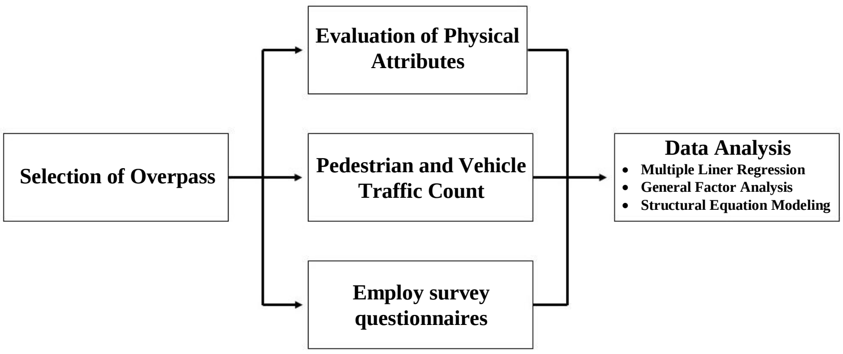


Figure 1 Workflow of the research

3.2 Study sites

The study was conducted in the Iligan City, a first-class highly-urbanized city in the region of Northern Mindanao, Philippines, with over 363,115 total population [27]. Four out of five overpasses in Iligan City were selected due to their distinguishable characteristics. The City was selected based on both the anecdotal evidence indicating pedestrians' reluctance to utilize overpass crossings and police records documenting road accidents involving pedestrians illegally crossing beneath the overpass facilities. The overpasses surveyed are: (1) Tambo Overpass (OP-1 for brevity), (2) MSU-IIT Badelles Overpass Transit Station (OP-2 for brevity), (3) Gaisano Mall Overpass (OP-3 for brevity); and (4) Brgy. Tominobo Overpass. The variation in overpass locations and characteristics allowed for a more diverse observation of pedestrian behavior and included all points-of-view necessary for the survey. The locations of the overpasses is as shown in Figure 2.

OP-1 is immediately nearby a T-intersection with no all-weather roofing (Figure 3a). OP-2 (Figure 3b) is directly in front of a university campus with barriers along the ourter lanes and the center of the road underneath (Figure 4). OP-2 is also 50m away from a signalize intersection. OP-3 (Figure 3c) is directly in front of a mall and within 50 meters away from a pedestrian lane. OP-4 (Figure 3d) is also directly in front of a school with only five (5) lanes of road underneath it. The height of the overpasses varies from 4.55 meters to 6.3 meters, with OP-2 having the shortest height and the OP-1 as the tallest. The stairway width of the overpasses also vary from 1.25 meters (OP-1 and OP-4) to 1.62 meters (OP-3). The span of the overpasses varies from 25 meters (OP-2) to 30.3 meters (OP-3). All three overpasses have six lanes underneath, except for OP-4 which has five lanes underneath. The riser height, tread length, and number of steps were excluded as part of the distinguishing physical characteristics of overpasses and were not part of the analyses since these are the same for all overpasses. The other physical attributes of the overpasses are summarized in Table 2.

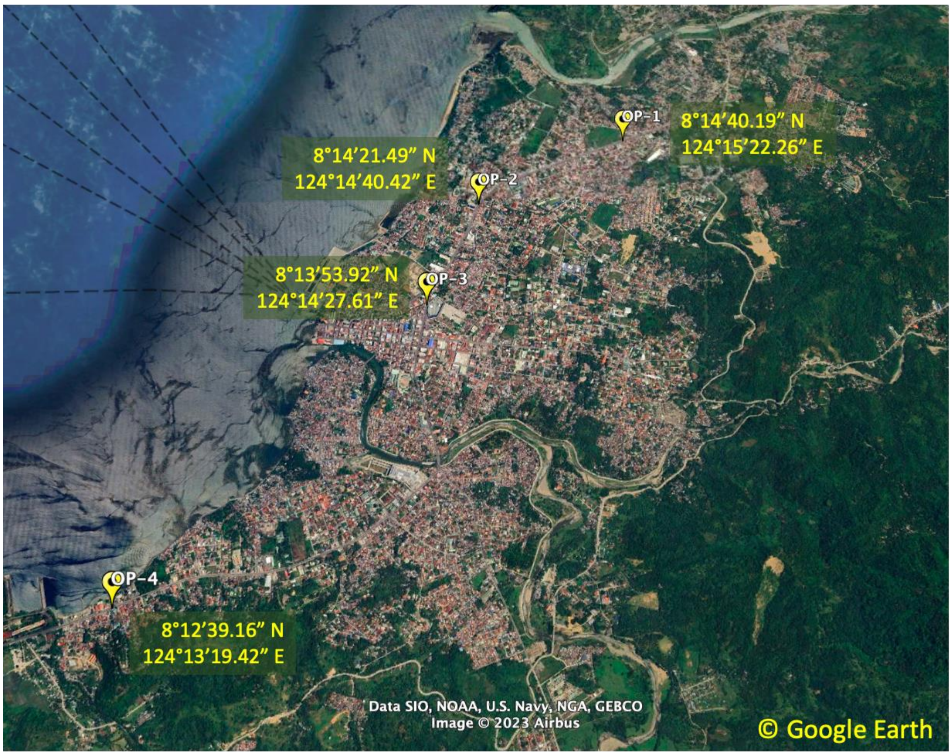
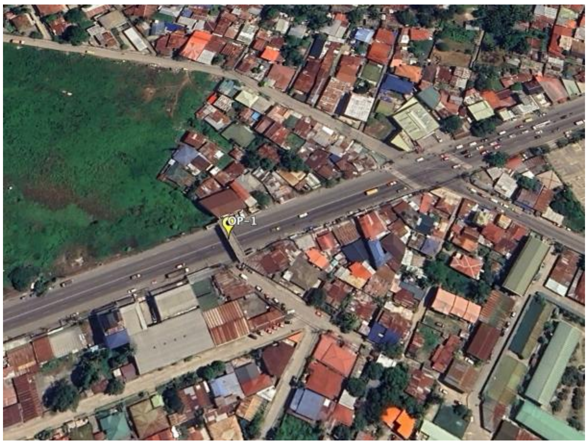
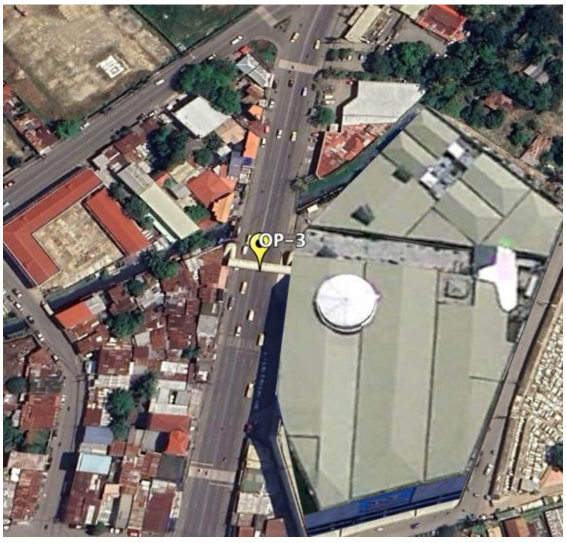


Figure 2 Location of four overpasses in Iligan City



(a) OP-1

(b) OP-2



(c) OP-3

(d) OP-4

Figure 3 Satellite image of the overpass vicinity

Figure 4 Barriers at MSU-IIT Badelles Overpass

Table 2 Physical attributes of the overpasses

Physical Attributes	OP-1	OP-2	OP-3	OP-4
Stairway Width (mm)	1250	1515	1620	1250
Overpass Width (mm)	3750	3600	2700	3810
Overpass Span (m)	28.3	25	30.3	25.25
Overall Height (m)	6.3	4.55	5.61	5.1
No. of stairway (per side)	1	2	1	2
Distance to nearest pedestrian lane (m)	113	83.65	33	65.7
No of Lanes (Main Road)	6	6	6	4
No of Service Lanes	0	0	0	1
Main Road Width (m)	3.25	3.25	3.25	3.25
Service Lane Width (m)	N/A	N/A	N/A	2
Total Road Width (m)	19.5	19.5	19.5	15
Detour distance (m)	40.9	35.85	41.35	36.81
Availability of Roofing	✗	✓	✓	✓
Provision of Road Barriers	✗	✓	✗	✗
Provision of Sidewalk Barriers	✗	✓	✗	✗
Provision of Pedestrian Signs	✓	✓	✓	✓
Other Distinguishable Characteristics:	Immediately nearby a T-intersection	Directly in front of a school and within 50 meters away from a signalized crossing	Directly adjacent to the mall and within 50 meters away from a pedestrian lane	Directly in front of a school with only 4 major lanes of road and 1 service lane

3.3 Pedestrian survey tool

Survey toll was developed to identify the latent factors influencing pedestrians' willingness to use the overpasses. The survey tool is in Appendix A. Part A of the survey intended to gather general information about respondents, while Part B gathered information on the pedestrian's perception of using overpasses. The survey tool were distributed randomly to pedestrians within the study locations and data were collected for seven days. A total of 227 respondents participated the survey.

General information (Part A) focused on demographic profile which include age, gender, education level, career, disability and having a driver's license. Previous studies show that factors such as age (see, e.g., Wu et al. [6], Rankavat and Tiwari [10], Banerjee et al. [12], Alver and Onelcin [20], Al Bargi and Daniel [21], Yanfeng et al. [22]), gender (see, e.g., Wu et al. [6], Banerjee et al. [12], Mutto et al. [17], Alver and Onelcin [20], Al Bargi and Daniel [21]), education level (see, e.g., Wu et al. [6]), career (see, e.g., Wu et al. [6]), disability, (see, e.g., Anciaes and Jones [24]), and having driver's license (see, e.g., Wu et al. [6]) all have significant influence on the preference of overpass use. Results from these studies were used in determining the variables of the survey. It was also recorded during the survey whether the respondents did or did not use the overpass when crossing.

The statements on the Part B of the survey tool were decided based on the aggregated factors obtained from extensive literature review on the factors affecting pedestrians' willingness to use overpasses. In particular the surveys used by Wu et al. [6] , Banerjee et al. [12], Yanfeng et al. [22] were referred in the development of the questionnaire used in the pedestrian survey. In crafting the statements, indicators for formulating a measurement model such as physical attributes of the overpass, the effect of traffic conditions, and many other different scenarios that represent the factors found during the review were considered. For example, statement Q3 ("The number of lanes of the road influences my decision to use the overpass.") relates to the physical attribute. Another example relevant to the behavior and norms is Q11 which states, "My preference to use the overpass can be affected by the opinion of other people." An example statement relevant to convenience is Q1 which states that "My decision to choose the overpass depends if I am carrying something heavy or something that uses both my hands." There was also a question which bluntly asked the crossing preference of the respondents embedded in the survey (Q5), which states "I prefer using the overpass when crossing the road at areas where overpasses are available." Q5 not used in the analysis for crafting the measurement model of the SEM, but were later used in the structural model of SEM (see Section 3.4). The respondents were asked on the level to which they agree or disagree to each statement in the survey tool using a 5-point Likert type scale ranging from ‘Strongly Disagree’, ‘Disagree’, Neutral. ‘Agree’, and ‘Strongly Agree.’ The reliability of the Part B of the survey tool was measure using Cronbach’s alpha, which is equal to 0.854, indicating a ‘good’ overall internal consistency [28].

3.4 Data analyses methods

Three sets of data were gathered from this research work: the respondents’ demographics, the physical attributes of the overpasses, and the survey questionnaire responses. These data sets were used to describe the general attitude of pedestrians’ willingness to use overpass in Iligan City. The analysis of the three sets of data were done in pats using multiple linear regressions (MLE), factor analysis, and structural equation modeling (SEM). All analysis were performed through RStudio Software 2022.02.2 Build 485. MLR is commonly used to predict an outcome variable based on multiple distinct predictor variables. MLR was used to model the respondents’ crossing choice – whether one did or did not use the overpass – as dependent variable. For the analysis, the data set corresponding to the respondents’ demographics and physical attributes of the overpasses were taken together as independent variables.

Factor analysis is a latent variable modeling paradigm in which set of observed variables are the indicators of the latent variables [29]. The latent variable is the primary interest, but it cannot be directly measured; however, it has direct influence on the observed variables [29]. The goal of factor analysis (FA) is to find the simplest way to interpret observed data [30] – in this case, the respondents’ answers to Part B of the survey tool. Due to space limitations, the reader is kindly referred to the literatures specifically containing the details of EFA, e.g., Finch and French [29], Loehlin and Beaujean [31], among others. FA compresses the data by associating the statements in Part B of the survey to few latent factor models, which creates the measurement model. Exploratory Factor Analysis (EFA) was used in this stage using RStudio 2022.02.2 Build 485. EFA begins by determining the number of latent factors to be included in the measurement model, which are decided from the results of either the eigenvalues or the parallel analysis considering factor loadings of the observable factors (statement of Part B). The factor loadings were then used to decide the associations of the observed variables and the latent factors retained through EFA, creating the measurement model for the structural equation modeling (SEM). Goodness-of-fit (GOF) tests were carried out in order to determine if the measurement model is to be accepted. In other words, EFA model is tested if it fits the data. Indices for GOF used are: (a) Root Mean Square Error of Approximation (RMSEA) with recommended range from 1.0 (Not Fit) to 0 (Perfect Fit), but <0.08 indicates the most acceptable model [32], (b) Standardized Root Mean Square Residual (RSMR) with values less than 0.05 required for an acceptable model fit [33]; and (c) Tucker-Lewis Index (TLI) with values above 0.90 are required for an acceptable model fit [34].

In SEM, the connections – causal paths – between latent variables are defined [29]. This is referred to model specification, which pertains to the definition of all causal paths between the latent variables obtained in EFA. The causal paths defined in all SEM analysis are direct influence only of the latent factors in EFA to Q5. A direct analysis between the latent variables and Q5 was done in order to assess the degree of influence that each latent variable has on the willingness of pedestrians to utilize the overpasses. A correlational analysis between the latent variables was employed in order to assess if the latent variables mutually influence one another or not. However, the results from the correlations were not considered in the discussions since only the direct influences of the latent factors were necessary for the discussions. The SEM procedure was also performed in RStudio 2022.02.2 Build 485. For a detailed explanation about SEM, the works of Finch and French [29], Loehlin and Beaujean [31], among others are referred.

Similar with the factor analysis, the SEM model was tested for goodness-of-fit to determine if the model is a good fit for the survey data, otherwise, modifications were done for models with poor fit. Indices for GOF used are: (a) RMSEA (recommended range is from 1.0 (Not Fit) to 0 (Perfect Fit), but <0.08 indicates the most acceptable model [32], (b) SRMR (recommended range is from 1.0 (Not Fit) to 0 (Perfect Fit), but <0.08 indicates the most acceptable model [33, 35], (c) TLI (values above 0.95 are required for an acceptable fit [34]); and (d) Comparative Fit Index (CFI) with values above 0.95 are required for an acceptable fit [36].

4. Results and discussions

4.1 Overpass pedestrian utilization

Table 3 consolidates the pedestrian traffic counts of the investigated overpasses. The utilization rate for each overpass was calculated as the ratio between the number of overpass users and the total number of crossing pedestrians. The determination of the effectiveness level adopted the criteria of Nadjam et al. [37]. Table 3 showed that OP-2 is ‘very effective’ with a utilization rate of 99.91%. This high utilization rate could be due to the existence of barriers on both sides and at the center of the road (see Figure 4). OP-3 and OP-4 overpasses are rated as ‘ineffective,’ with the OP-3 having a utilization rate of 35.74% and OP-4 having a 21.79% utilization rate. OP-1 is rated as ‘very ineffective’ with only 157 overpass users of the 1,388 crossing pedestrians with a utilization rate of 11.31%. OP-1 overpass is observed to have no all-weather roofing, there is an issue with cleanliness, and it has the tallest overall height, which could have negatively affected the utilization rate. In summary, about 8386 pedestrians were observed during the survey, 3222 of which used the overpasses while 5164 did not. The average proportion of pedestrians who used the overpass when crossing the street is about 38.42%, suggesting that that the overpasses in Iligan City are generally ‘ineffective.’

Table 3 Utilization Rate of the Overpasses

Overpass	Overpass User	Overpass Non-user	Utilization Rate	Effectiveness Level
OP-1	157	1231	11.31%	*Very Ineffective*
OP-2	1149	1	99.91%	*Very Effective*
OP-3	1644	2956	35.74%	*Ineffective*
OP-4	272	976	21.79%	*Ineffective*
OVERALL	3222	5164	38.42%	*Ineffective*

On the other hand, the volume per 2-hour interval and average speeds of vehicles passing underneath the overpasses are summarize in Table 4. The average vehicle volume was the highest on the street of OP-2 with an average of 7,106 per 2-hr interval, followed by OP-4 (5,809 vehicles per 2hr interval), OP-3 (4,692 vehicles per 2hr interval), and lastly OP-1 with the least average 4,059 vehicles per 2-hr interval. The data shows that vehicles passing through OP-3 have the highest average speed of 32.30 km/hr, followed by OP-

1 with an average speed of 31.10 km/hr, OP-2 with the highest vehicle volume with an average speed of 24.47 km/hr, and lastly, OP-4 with the lowest vehicle average speed of 24.45 km/hr. Vehicle volume and speed observations suggests the need of overpass structures at the locations investigated to prevent potential hazards to both vehicle owners and pedestrians.

Table 4 Average vehicle counts and vehicle speed per 2hr interval at overpasses

Overpasses	MONDAY		WEDNESDAY		FRIDAY			
	Average Vehicle Count	Average Speed	Average Vehicle Count	Average Speed	Average Vehicle Count	Average Speed	Overall Average Vehicle Count	Average Speed
OP-1	4,087	31.37	4,027	30.68	4,063	31.24	4,059	31.10
OP-2	7,329	24.35	6,493	24.49	7,496	24.56	7,106	24.47
OP-3	4,859	31.98	4,470	32.39	4,746	32.54	4,692	32.30
OP-4	6,138	24.57	5,754	24.42	5,534	24.36	5,809	24.45

4.2 Respondents profile

A total of 227 respondents participated (both overpass users and non-users) the survey. This samples size is about 82.90% of the target number of respondents based on the average pedestrian traffic counts of users and non-users of the overpass and following the Fisher's formula [38]. Moreover, as a rule of thumb for Structural Equation Modeling, the minimum number of sample is 100 or 200 [39]. Table 5 shows the distribution of respondents showing relatively balanced number of overpass users (46.7%) and non-users (53.3%). In this case, overpass users are pedestrians who used the overpass to cross the road, while overpass non-user are pedestrians who crossed the road illegally. This distribution is ideal to have a fair view in the responses of both uses and non-users.

Table 5 Distribution of respondents, user and non-user of overpass per location.

Type of Pedestrian	Tambo Overpass	MSU-IIT Badelles Overpass	Gaisano Mall Overpass	Brgy. Tominobo Overpass	Total
Overpass User	21	26	28	31	106
Non-user of Overpass	38	32	28	23	121
TOTAL	59	58	56	54	227

The summary of the respondents' profile based the "Part A" of the survey tool (see Appendix A) is summarize in Figure 5. Most respondents are between the ages 21 and 40 years old (64%), with only 5% are of the age bracket 61 and older. In terms of gender, about 59% of the respondents are male and 41% are female. Only about 4% of these respondents have a disability, and around a quarter (26 %) of the respondents have a valid driver's license. About 65% of the respondents have educational attainment up to tertiary level, followed by 30% under secondary level, and 5% for primary level. Half of the respondents are under Class V (unemployed, full-time homemakers, students and subsistence farmers), 20% are under Class I (senior public servants, professionals, managers, large-scale traders, businessmen and contractors), followed by 16% for Class IV (petty traders, laborers and messengers), 8% under Class II (intermediate grade public servants and senior high school teachers), and 6% for Class III (junior school teachers, professional drivers and artisans). The demographic information was included in the multiple linear regression model (see Section 4.4) to determine whether demographic variation influenced pedestrians' overpass utilization preference.

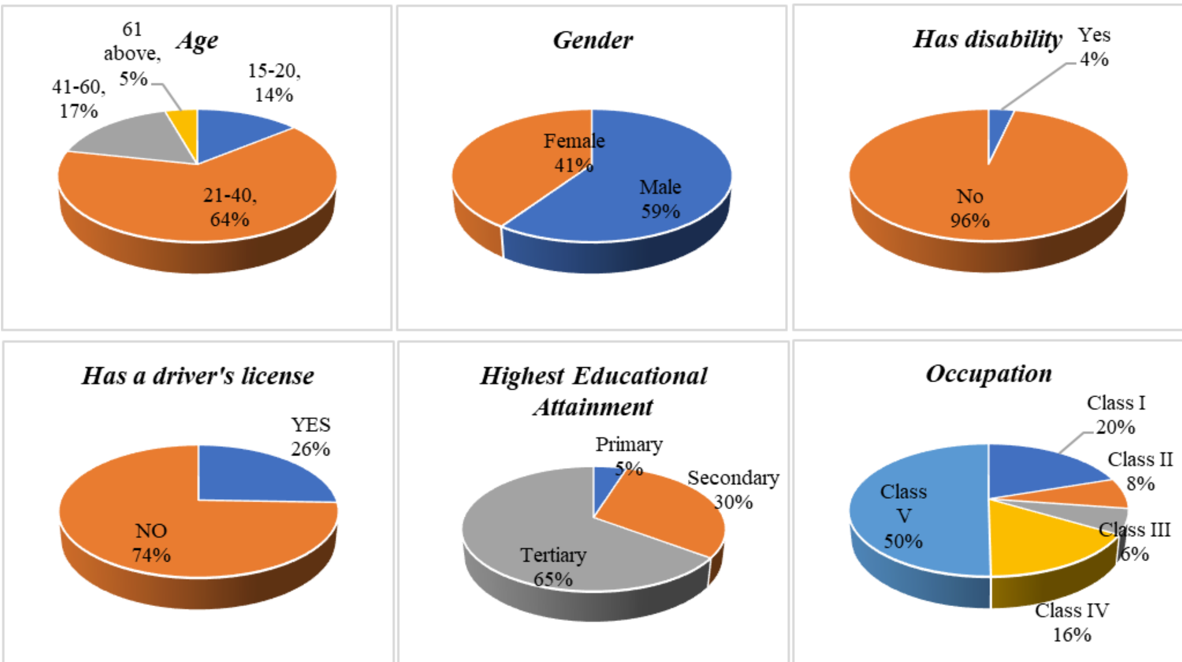


Figure 5 Demographic percentage distribution of 227 respondents.

4.3 Result of the survey

The summary statistics of the responses to the Part B of the survey are shown in Table 6. From the table, Q11 has the highest coefficient of variation (COV), which implies that the influence of the opinion of other people over utilizing the overpass varies widely among the respondents. On the other hand, Q4 has the lowest COV, suggesting that generally pedestrians felt that using overpasses is safer when crossing the road. However, this does not necessarily imply that pedestrians will prefer to use the overpass in crossing the street.

In Table 6, Q5 was dedicated to provide insight on whether pedestrians would prefer to use the overpass when crossing the street. The data for Q5 shows a mean of 3.885 and a COV of 0.333, implying that pedestrians would generally prefer using the overpass if they are available. This is contrary to what was observed in the overpass utilization survey. Nevertheless, this could be analyzed that pedestrians may have some intention to use the overpass, but their ultimate decision remains to be affected by other factors. Data from Q1 to Q25, except for Q5 were used as input indicators for EFA, while Q5 was used in SEM analysis as indicator of the preference of pedestrians on overpass utilization.

Table 6 Descriptive statistics for questionnaire survey responses.

Variable	Mean	Median	Min	Max	Standard deviation	COV
Q1	3.225	4	1	5	1.466	0.455
Q2	4.035	4	1	5	1.187	0.294
Q3	3.489	4	1	5	1.384	0.397
Q4	4.471	5	1	5	1.063	0.238
Q5	3.855	4	1	5	1.284	0.333
Q6	3.432	4	1	5	1.324	0.386
Q7	3.692	4	1	5	1.288	0.349
Q8	3.423	4	1	5	1.316	0.384
Q9	3.599	4	1	5	1.305	0.363
Q10	3.498	4	1	5	1.361	0.389
Q11	2.493	2	1	5	1.361	0.546
Q12	3.167	3	1	5	1.337	0.422
Q13	3.150	3	1	5	1.336	0.424
Q14	3.700	4	1	5	1.395	0.377
Q15	3.877	4	1	5	1.342	0.346
Q16	3.004	3	1	5	1.397	0.465
Q17	2.802	3	1	5	1.439	0.514
Q18	2.991	3	1	5	1.311	0.438
Q19	2.771	3	1	5	1.414	0.510
Q20	3.753	4	1	5	1.188	0.317
Q21	3.718	4	1	5	1.389	0.374
Q22	3.687	4	1	5	1.339	0.363
Q23	3.546	4	1	5	1.354	0.382
Q24	2.819	3	1	5	1.395	0.495
Q25	3.388	4	1	5	1.414	0.417

4.4 Results of the multiple linear regression analysis

The set of independent variables used in the multiple regression analysis consists of 16 predictor variables (or independent variables) combining the pedestrians' demographic information (Section 4.2) and the physical attributes of the overpasses (Table 2). The crossing choice – referring to whether the respondent did or did not use the overpass – was based on the data from Table 5. The multivariate linear model excluded the data from OP-2 because the presence of barriers along the road may have influenced the data. To remove this bias, our model considers the subset data for OP-1, OP-3, and OP-4 only. Tables 6 shows the summary statistics of the multivariate model. The p-value of the F-statistic of the model is equal to 0.001826, implying that at least one of the independent variables is significantly related to the selective preference of overpass use.

In interpreting the multivariate linear model, F-statistic and the p-value were used as predictors, and an $\alpha = 0.05$ was used as the cutoff for the level of significance for the independent variables. From Table 7, amongst the predictor variables, having driver's license, the overpass width, and the overpass span are the significant predictors with p-values < 0.05. This means that pedestrians with driver's license will most likely use the overpass in crossing. This finding corroborates with the study of Holland and Hill [40], indicating that drivers and nondrivers are not making decision in the same way towards crossing a street in a risky situations. Pedestrians with driver's license perceive road accident risk differently than non-drivers due to experience. On the other hand, the result also suggests that an increase in overpass width and span will most likely cause pedestrians not to use the overpass. The overpass span may increase pedestrian travel time, which could be an encouraging factor for pedestrians to avoid overpass crossings. For overpass width, the finding could be counterintuitive. The authors suspect that the width, which is correlated to the size of the overpass stairway could impact on the flowrate of pedestrians using the overpass (e.g., Shah et al., [41]), hence affecting their decisions to use the overpass. Nevertheless, this may require further investigations to fully understand these relationships.

Interestingly the factors such as age, gender, highest educational attainment, occupation, and having a disability are not significant for the multiple regression model. In other words these variables do not have a significant effect on the selective preference of overpass use. Eight of predictor variables are not defined because of singularities shown with NAs in Table 7. It is, however, important to note that the results of MLR presented here could have limited applications for predictive analysis due to a low R-squared value of the model. However, the results is useful in discerning which variables are likely to influence pedestrians' decisions regarding the use of overpass.

Table 7 Multiple linear regression analysis for OP-1, OP-3, and OP-4

Variable	Coefficients: (8 not defined because of singularities)			
	Coefficient (b)	Std. Error	t value	Pr (>|t|)
(Intercept)	7.09688	1.51034	4.699	5.6e-06 ***
Age	-0.18059	0.13842	-1.305	0.19389
Gender	0.05163	0.21674	0.238	0.81201
Has a driver's license	0.56336	0.25601	2.201	0.02920 *
Highest educational attainment	0.31109	0.16430	1.893	0.06011
Occupation	-0.07909	0.07000	-1.130	0.26025
Has disability	0.46660	0.74341	0.628	0.53113
Overpass width	-0.55291	0.24165	-2.288	0.02345 *
Overpass span	-1.16452	0.41522	-2.805	0.00566 **
Overpass height	NA	NA	NA	NA
Stairway width	NA	NA	NA	NA
Number of stairways per side	NA	NA	NA	NA
Distance to nearest pedestrian lane	NA	NA	NA	NA
Road width	NA	NA	NA	NA
Detour distance	NA	NA	NA	NA
Vehicle volume	NA	NA	NA	NA
Average speed	NA	NA	NA	NA

Multiple R-squared: 0.1401, Adjusted R-squared: 0.09706
F-statistic: 3.257 on 8 and 160 DF, p-value: 0.001826

4.5 Results of the exploratory factor analysis

EFA was performed in R using RStudio 2022.02.2 Build 485 environment to examine if there are latent factors contributing to the pedestrian's preference on overpass use besides the measured factors considered in the multiple linear regressions. The EFA also excluded the responses taken from the OP-2 for the same reason stated in Section 4.4. Eigenvalues could be used to discriminate the number of latent factors specified in EFA model. As a rule of thumb, latent factors with eigenvalues greater than 1 can be retained in the measurement model [42]. Table 8 shows the suggested number of latent factors based on eigenvalues. Moreover, a parallel analysis was also performed to corroborate the suggested number of latent factors as shown in Figure 6.

Table 8 Eigenvalues for the 8 latent factors

No of Latent Factors	Eigenvalue
1	5.5107804
2	2.6367717
3	1.7377166
4	1.5849244
5	1.3498730
6	1.2898320
7	1.1231475
8	1.0161514

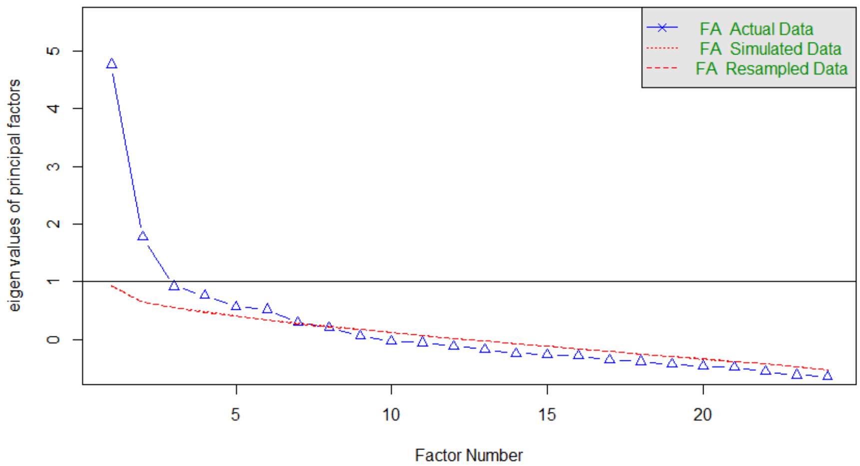


Figure 6 Parallel analysis scree plot for EFA

In the final measurement model, the number of latent factors was decided based on the results of the parallel analysis in which six latent factors retained, explaining at least 50% of the variance. Promax rotation was performed and assuming correlations among the latent factors, the graphical representation of the measurement model is shown in Figure 7. The figure shows the statements that are associated with each latent factor based on the factor loadings. The latent factors are subjectively labeled subjectively based only the statements associated with each latent factor (see e.g., [42-44]).

In Figure 7, it could be interpreted that Factor 1 influences Q11, Q18, Q13, Q17, and Q24. Factor 1 is labeled as 'External Influence and Norm' that could influence pedestrian preference on overpass use, which are described in the model as perceived social pressure, the crossing time, the relative position of vehicle, overpass width, and overpass height. For Factor 2, the model indicates that it influences Q9, Q19, Q1, and Q10. Factor 2 relates to 'Convenience' which influences pedestrians' daytime or nighttime preference, if they are carrying items, and depending on the traffic volume of the street below the overpass. The result for the other 4 latent factors, labeled as shown in Figure 7, could be interpreted in the same manner.

Figure 7 also shows that Perceived Social Pressure (Q11), Stairway Width (Q17), Fear of Crime (Q16), and Target Destination (Q8) all have loadings small factor loading, allowing them to be eliminated in the model. However, none were lower than 0.35, thus these factors could still be considered to have marginal effects and are retained in the measurement model. The results of EFA also corroborate with the findings of the extant literature over the contribution of some of the physical attributes of the overpass on the preference of pedestrians on overpasses use (Section 2).

Several latent factors in EFA model are found to be significantly correlated (see, e.g., [45]). For example, External Influence & Norms (Factor 1), Convenience (Factor 2), and Safety (Factor 4) are all strongly correlated to the 6th latent factor, which is Facility Features and Location. This implies that these latent factors can be combined, resulting into a 3-latent factor model. However, in this analysis, a 6-latent factor model is decided since combining the correlated latent factors would group the majority of the observable variables into a single latent factor, which could complicate model interpretation. Table 9 summarizes the values of different model fitness indices (RMSEA, RMSR, and TLI) used to check the adequacy of the model to the data. The results indicate that the 6-latent factor measurement model adequately fits the survey data.

Table 9 EFA Model Goodness of Fit Indices

Fit Test	Index Value	Indication	Result	Assessment
RMSEA	> 0.08	Poor Fit	0.08	Adequate Fit
	0.05 - 0.08	Adequate Fit		
	< 0.05	Good Fit		
SRMR	< 0.05	Good Fit	0.04	Good Fit
TLI	> 0.90	Good Fit	0.736	Poor Fit but not Extreme

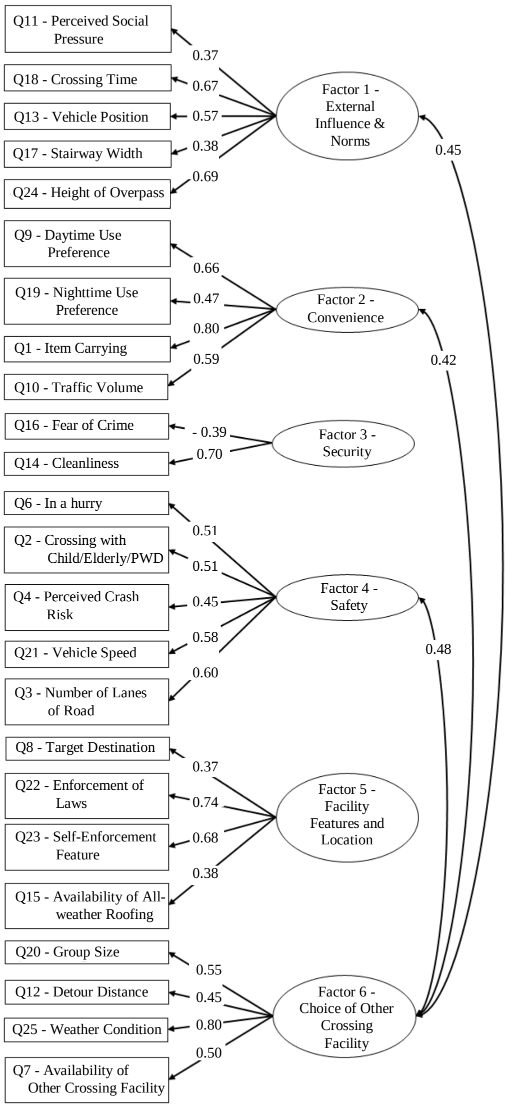


Figure 7 Measurement model showing the latent factors

4.6 Results of the structural equation modeling

SEM is used in order to determine the influence of each latent factors determined from EFA on the willingness of pedestrians to utilize overpasses (Q5). A direct path analysis is done to explain this relationship, which means the inter-correlated influences between the latent factors were not considered to simplify the analysis. Moreover, data from OP-2 were neglected in SEM for the same reason provided in the previous analysis. The graphical representation of the results of SEM is presented in Figure 8.

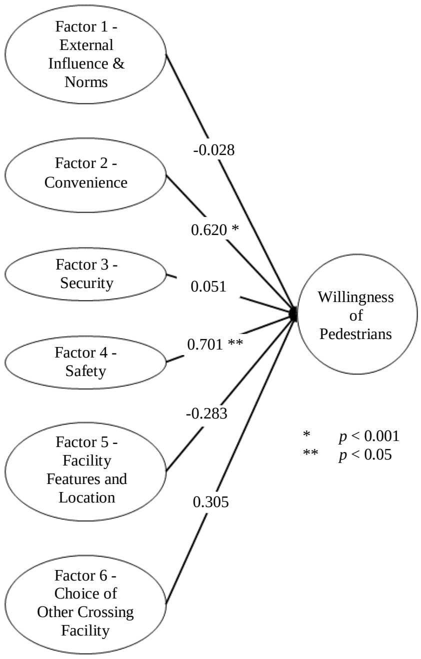


Figure 8 Structural model of the latent factors

Figure 8 shows that among the six latent factors, only two latent factors (Factor 2 and 4) have a significant direct influence towards the willingness of pedestrians to utilize overpasses. Safety (Factor 4) had the largest influence with a factor loading of 0.701 and with a p-value of less than 0.05. Factor 4 is associated with conditions that endangers the life of pedestrians, such as vehicle speed, perceived crash risk, and the number of lanes underneath overpasses. Factor 4 is also associated with situations in which pedestrians are hurriedly crossing and if pedestrians are crossing with child, elderly, or with persons with disability (PWD). When threat to life is high due to these conditions, pedestrians would prefer using the overpass.

Convenience (Factor 2) is the next influential latent factor, having positive and direct influence on pedestrians' willingness to use the overpass with a factor loading of 0.601 and with a p-value less than 0.001. The observed factors directly influenced by the latent factor of Convenience (Factor 2) includes: Daytime Use Preference (Q9), Nighttime Use Preference (Q19), Items Carrying (Q1), and Traffic Volume (Q10). This means that overpasses that caters for pedestrians' convenience and are more accessible would make pedestrians prefer to use them. The results of the SEM for EFA Model 2 also aligns with the study conducted by Rankavat and Tiwari [10] which found convenience and safety perceptions to be significant for the usage of facilities at locations with an overpass. Some studies report that pedestrians are less likely to feel stressed and are more relaxed when using the overpass as they need not worry about the speed and number of passing vehicles (see, e.g., [46]). Overpass design, therefore, could concentrated on improving safety and in providing more convenience to pedestrians to encourage pedestrians to utilize these facilities.

Table 10 summarizes the values of the model fit indices (RMSEA, SRMR, CFI, and TLI) used to verify the adequacy of the structural model in Figure 8. Considering the four indices, it can be said that the 6-latent variable structural equation model, by considering only direct influences, is fit for the survey data regarding the willingness of pedestrians to utilize the overpasses.

Table 10 SEM Model Goodness of Fit Indices

Fit Test	Index Value	Indication	Result	Assessment
	> 0.08	Poor Fit		
RMSEA	0.05 - 0.08	Adequate Fit	0.062	Adequate Fit
	< 0.05	Good Fit		
SRMR	< 0.08	Good Fit	0.091	Poor Fit
CFI	> 0.9	Good Fit	0.929	Good Fit
TLI	> 0.9	Good Fit	0.915	Good Fit

5. Conclusions

This paper set out to elucidate the factors that influence pedestrians' overpass use preference, in which 4 overpass in Iligan City, Philippines were investigated as a case study. Pedestrian traffic counts of these overpasses revealed that on average these facilities could be regarded as ineffective with a utilization rate of only 38.42%. This confirms that majority of pedestrians prefer not using overpasses when crossing the streets. The low utilization rate of overpasses underscores the need for strategic interventions to enhance their effectiveness and promote safer pedestrian practices. Multiple linear regression analysis of the collected physical attributes of the overpasses and demographic data revealed three contributing factors are significantly associated with the preference of pedestrians on overpass use, which are: having driver's license, the overpass span, and the overpass width. It was also clarified that age, gender, highest educational attainment, occupation, and having a disability do not significantly influence pedestrians' overpass use preference. Exploratory factor analysis revealed that there are 6 latent factors influencing pedestrians overpass use preferences, which are: external influence and norms, convenience, security, safety, facility features and location, and the choice of other crossing facility. Among these 6 latent factors, structural equation modeling elucidates that convenience and safety are the most influence factors influencing pedestrian's overpass utilization preference. Considering the factors identified to influence pedestrian overpass preference, urban planners should prioritize convenience and safety in the design and placement of overpasses such as incorporating self-enforcing features. Moreover, the influence of external factors and norms suggests the importance of community engagement and public awareness, which could help shift behavioral patterns. Additionally, policy improvements such as strictly enforcing traffic laws to prioritize pedestrian safety and implementing traffic calming measures around overpasses could further encourage their utilization. Finally, there is a need to delve deeper into the dynamics of pedestrian behavior in urban environments, considering variables such as cultural influences, economic factors, and technological advancement.

6. References

[1] Ren G, Zhou Z, Wang W, Zhang Y, Wang W. Crossing behaviors of pedestrians at signalized intersections: observational study and survey in China. Transp Res Rec. 2011;2264(1):65-73.

[2] Zeng Q, Wang Q, Zhang K, Wong SC, Xu P. Analysis of the injury severity of motor vehicle-pedestrian crashes at urban intersections using spatiotemporal logistic regression models. Accid Anal Prev. 2023;189:107119.

[3] European Commision, European Road Safety Observatory. Facts and figures – pedestrians [Internet]. 2020 [cited 2024 Jan 3]. Available from: https://road-safety.transport.ec.europa.eu/system/files/2021-07/facts_figures_pedestrians_final_20210323.pdf.

[4] World Health Organization (WHO). Global status report on road safety [Internet]. 2015 [cited 2024 Jan 3]. Available from: https://www.afro.who.int/sites/default/files/2017-06/9789241565066_eng.pdf.

[5] Obinguar DD, Iryo-Asano M. Macroscopic analysis on the frequency and severity of pedestrian crashes in National Roads in Metro Manila, Philippines. IATSS Res. 2021;45(4):521-9.

[6] Wu Y, Lu J, Chen H, Wu L. Identification of contributing factors to pedestrian overpass selection. J Traffic Transp Eng (Engl Ed). 2014;1(6):415-23.

[7] Zhang C, Chen F, Wei Y. Evaluation of pedestrian crossing behavior and safety at uncontrolled mid-block crosswalks with different numbers of lanes in China. Accid Anal Prev. 2019;123:263-73.

[8] Truong LT, Nguyen HTT, Nguyen HD, Vu HV. Pedestrian overpass use and its relationships with digital and social distractions, and overpass characteristics. Accid Anal Prev. 2019;131:234-8.

[9] Sharples JM, Fletcher JP. Pedestrian perceptions of road crossing facilities. Edinburgh: Scottish Executive Central Research Unit; 2001.

[10] Rankavat S, Tiwari G. Pedestrians perceptions for utilization of pedestrian facilities–Delhi, India. Transp Res F: Traffic Psychol Behav. 2016;42:495-9.

[11] Guo H, Zhao F, Wang W, Zhou Y, Zhang Y, Wets G. Modeling the perceptions and preferences of pedestrians on crossing facilities. Discrete Dyn Nature Soc. 2014;2014:949475.

[12] Banerjee A, Raoniar R, Maurya AK. Pedestrian overpass utilization modeling based on mobility friction, safety and security, and connectivity using machine learning techniques. Soft Comput. 2020;24:17467-93.

[13] Webb T, Joseph J, Yardley L, Michie S. Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. J Med Internet Res. 2010;12(1):e4.

[14] Sheykhfard A, Haghighi F. Driver distraction by digital billboards? structural equation modeling based on naturalistic driving study data: a case study of Iran. J Saf Res. 2020;72:1-8.

[15] Sisiopiku VP, Akin D. Pedestrian behaviors at and perceptions towards various pedestrian facilities: an examination based on observation and survey data. Transp Res F: Traffic Psychol Behav. 2003;6(4):249-74.

[16] Shoabjareh AH, Mamdoohi AR, Nordfjærn T. Analysis of pedestrians' behaviour: a segmentation approach based on latent variables. Accid Anal Prev. 2021;157:106160.

[17] Mutto M, Kobusingye OC, Lett RR. The effect of an overpass on pedestrian injuries on a major highway in Kampala–Uganda. Afr Health Sci. 2002;2(3):89-93.

[18] Hasan R, Napiah M. The perception of Malaysian pedestrians toward the use of footbridges. Traffic Inj Prev. 2018;19(3):292-97.

[19] Sangphong O, Siridhara S. A study of footbridge utilization behavior in Nakhon Ratchasima. Rev Integr Bus Econ Res. 2014;3:93-100.

[20] Alver Y, Onelcin P. Gap acceptance of pedestrians at overpass locations. Transp Res F: Traffic Psychol Behav. 2018;56:436-43.

[21] Al Bargi WA, Daniel BD. Modelling Pedestrians' utilization of crossing facilities along urban streets. Case Stud Transp Policy. 2020;8(2):593-8.

[22] Yanfeng W, Shunying Z, Hong W, Bing L, Mei L. Characteristic analysis of pedestrian violation crossing behavior based on logistics model. 2010 International Conference on Intelligent Computation Technology and Automation; 2010 May 11-12; Changsha, China. USA: IEEE; 2010. p. 926-8.

[23] Bandara D, Hewawasam C. A comparative study on effectiveness of underpass and overpass among pedestrians in different urban contexts in Sri Lanka. J Serv Sci Manag. 2020;13(5):729-44.

[24] Anciaes PR, Jones P. Estimating preferences for different types of pedestrian crossing facilities. Transp. Res. F: Traffic Psychol. Behav. 2018;52:222-37.

[25] Peters D, Kim L, Zaman R, Haas G, Cheng J, Ahmed S. Pedestrian crossing behavior at signalized intersections in New York City. Transp Res Rec. 2015;2519:179-88.

[26] Hełdak M, Kurt Konakoglu SS, Kurdoglu BC, Goksal H, Przybyła B, Kazak JK. The role and importance of a footbridge suspended over a highway in the opinion of its users— Trabzon (Turkey). Land. 2021;10(4):340.

[27] Philippine Statistics Authority. 2020 Census of population and housing. Philippine: PSA; 2020.

[28] Taber KS. The use of Cronbach's Alpha when developing and reporting research instrument in science education. Res Sci Educ. 2018;48:1273-96.

[29] Finch WH, French BF. Latent variable modeling with R. New York: Routledge; 2015.

[30] Harman HH. Modern factor analysis. Chicago: University of Chicago press; 1976.

[31] Loehlin JC, Beaujean AA. Latent variable models – an introduction to factor, path, and structural equation analysis. 5th ed. New York: Routledge; 2017.

[32] Browne MW, Cudeck R. Alternative ways of assessing model fit. In: Bollen KA, Long JS, editors. Testing structural equation models. Newbury Park: Sage; 1993. p. 136-162.

[33] Jöreskog KG, Sörbom D. LISREL 8: Structural equation modeling with the SIMPLIS command language. Lincolnwood: Scientific Software International; 1993.

[34] Tucker LR, Lewis C. A reliability coefficient for maximum likelihood factor analysis. Psychometrika. 1973;38:1-10.

[35] Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Modeling. 1999;6(1):1-55.

[36] Bentler PM. Comparative fit indexes in structural models. Psychol Bull. 1900;107(2):238-46.

[37] Nadjam A, Ferdiansyah M, Sitorus HJ. Efectivitas dan kepuasan pengguna jembatan penyeberangan orang (JPO) di pasar induk kramat jati. Politeknologi. 2018;17(1):33-44. (In Indonesian)

[38] Charan J, Biswas T. How to calculate sample size for different study designs in medical research?. Indian J Psychol Med. 2013;35(2):121-6.

[39] Boomsma A. Nonconvergence, improper solutions, and starting values in LISREL maximum likelihood estimation. Psychometrika. 1985;50:229-42.

[40] Holland C, Hill R. The effect of age, gender and driver status on pedestrians' intentions to cross the road in risky situations. Accid Anal Prev. 2007;39(2):224-37.

[41] Shah J, Joshib GJ, Parida P. Behavioral characteristics of pedestrian flow on stairway at railway station. Procedia Soc Behav Sci. 2013;104:688-97.

[42] Williams B, Onsman A, Brown T. Exploratory factor analysis: a five-step guide for novices. Australas J Paramed. 2010;8:1-13.

[43] Osborne JW, Costello AB, Kellow JT. Best practices in exploratory factor analysis. In: Osborne J, editor. Best Practices in Quantitative Methods. London: Sage; 2008. p. 86-99.

[44] Yong AG, Pearce S. A beginner's guide to factor analysis: focusing on exploratory factor analysis. Tutor Quant Methods Psychol. 2013;9:79-94.

[45] Shortell T. An introduction to data analysis & presentation [Internet]. 2001 [cited 2024 Jan 3]. Available from: http://academic.brooklyn.cuny.edu/soc/courses/712/chap18.html.

[46] Zareharofteh F, Eslami M. Pedestrians' outstanding beliefs regarding bridge use–a directed content analysis. Health Educ Health Promot. 2021;9(2):127-34.

Appendix A

Part A: Respondent's Profile
(Age, Gender, Having a driver's license, highest educational attainment, occupation, and having a disability)

Part B: Statements relevant to overpass use (answerable in a Likert scale fashion, 1-strongly disagree, 2-disagree, 3-not sure, 4-agree, 5-stongly agree)
Q1: My decision to choose the overpass is influenced if I am carrying something heavy or that uses up both my hands.
Q2: My decision to use the overpass is influenced if I am crossing with somebody that needs accompaniment (child/children, elderly, or person with disability).
Q3: The number of lanes of the road influences my decision to use the overpass.
Q4: I feel more safe if I use the overpass in crossing the road.
Q5: I prefer using the overpass when crossing the road at areas where overpasses are available.
Q6: My decision to use the overpass is affected if I am in a hurry.
Q7: Availability of nearby pedestrian lanes can affect my decision to use the overpass in crossing.
Q8: My target destination has an effect on whether I use the overpass.
Q9: I am more inclined to use the overpass during the daytime.
Q10: The number of vehicles on the road affects my decision to use the overpass.
Q11: My preference to use the overpass can be affected by the opinion of other people.
Q12: The additional distance when using the overpass affects my decision to use them or not.
Q13: The proximity of the vehicles from my position affects my decision on whether I use the overpass or not.
Q14: If the overpass is clean, I am more inclined to utilize it.
Q15: I am more inclined to use an overpass if it has an all-day roofing.
Q16: I feel that there is a possibility that I might experience getting robbed in the overpass.
Q17: The width of the stairway can influence my decision to use the overpass.
Q18: The additional time consumed when using the overpass affects my decision to use them or not.
Q19: I prefer to use the overpass during the nighttime.
Q20: I am more inclined to use the overpass if a group of people also uses them.
Q21: The speed of the vehicles influence my decision to use the overpass.
Q22: The implemented laws against illegal crossing can affect my decision to use the overpass.
Q23: The presence of either pedestrian signs, and road barriers can influence my likelihood to use an overpass.
Q24: The total height of the overpass has an effect on my decision to use the overpass.
Q25: My usage of overpasses depends on the weather condition.