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INSTITUTE OF ENGINEERING
PULCHOWK CAMPUS**

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**An Assessment of Utilization, Compliance and User Awareness of
Pelican Crossings: A Case Study of Midblock Crossings at the
Gwarko-Lamatar Road**

by

Merina Shrestha

A THESIS

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THE
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**DEPARTMENT OF CIVIL ENGINEERING
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ABSTRACT

Pedestrian safety is a growing concern in Nepal's urban environments, where high rates of pedestrian fatalities highlight the need for improved crossing infrastructure. Pedestrian activated traffic control system, known as Pelican crossings have been introduced in some areas to improve pedestrian safety. However, their effectiveness depends on public awareness, compliance with signals, and utilization rates, which remain largely undocumented. The purpose of this study is to evaluate the use and effectiveness of Pelican crossings by assessing overall awareness, pedestrian utilization behavior and compliance with the pedestrian signals. A mixed-methods approach, including video graphic and questionnaire surveys, is employed to gather data on pedestrian interaction with Pelican crossings.

Binary logistic regression modeling was done on IBM SPSS to develop the awareness, utilization and walking compliance model.

Findings reveal that despite males having higher awareness, they are less likely to utilize the crossings, and exhibit impulsive road crossing behaviors, the children/adolescents have the highest knowledge amongst all and also use the pushbuttons more often while elderly pedestrians exhibit the lowest utilization rates. Compliance decreases with increased waiting time; significantly reducing it after 60 seconds, lower traffic volume, and evening hours. The lone commuters have the highest likelihood of using the pushbuttons whereas the larger groups show higher compliance.

The study recommends targeted awareness campaigns, optimized signal timing, improved visibility and signage, and stricter enforcement to enhance pedestrian safety and increase the effectiveness of Pelican crossings introduced in an attempt to provide safer crossing points.

Keywords: Pedestrian safety, Pelican crossings, Compliance, Awareness, Logistic regression, Utilization

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LIST OF ABBREVIATIONS

TCCR	Temporal crossing compliance rates
SCCR	Spatial crossing compliance rates
OCCR	Overall crossing compliance rates
CA	Crosswalk Area
WHO	World Health Organization
VRU	Vulnerable Road Users
CIA	Crosswalk Influence Area
MLR	Multiple Linear Regression
FOB	Foot Over Bridges
df	Degree of freedom

CHAPTER 1: INTRODUCTION

1.1 Background

Pedestrian safety is an essential component of traffic management, especially given the global rise in road crashes. (WHO, 2023) Statistics shows that approximately 1.19 million people die every year as a consequence of road traffic crashes. More than 50% of all the road traffic deaths are among vulnerable road users (VRUs), including pedestrians, cyclists and motorcyclists World Bank (2020) reported that VRUs accounted for around 72 percent of all road fatality victims, which consists of around 50 percent pedestrians. Throughout 2001 to 2013 (Rajendra Karkee, 2016) documented 95,902 car crashes and 100,499 injuries followed by 14,512 road deaths. Over three-quarters of these crashes involve motorcyclists and pedestrians, and most of them take place at the intersections or at midblock crossings; an indication of the importance of taking steps to improve pedestrian safety through a systematic approach. Pelican crossings, a type of signal-controlled pedestrian crossing, allows individuals to safely cross roads by regulating traffic through a push-button mechanism. These ones, intended to offer safer crossing opportunities, when pressed a button, triggers a stop signal for vehicles and a “green man” signal for pedestrians to cross. Unlike conventional zebra crossings, the structured nature of Pelican crossings tends to decrease the chaotic and risky behaviors that is commonly seen at uncontrolled crossings.

The Pelican crossing was first introduced to British roads in 1969 as an improvement over zebra crossings, which relied solely on driver compliance. It focused to give pedestrians more control over road traffic while diminishing unnecessary delays for vehicles. Pelican crossings, though originally developed in the UK, have been adopted in several countries with varying adaptations. In Nepal, it was first introduced in November 2023, with the initial installation in the Babarmahal area of Kathmandu (whatthenepal.com). The Pelican system works by displaying a green signal for pedestrians at the zebra crossing when they push the button. The green light lasts for 20 seconds, while the vehicles are shown a red signal. After 20 seconds, the system can be activated again after a two-minute i.e. 120 second of waiting period. Although traffic lights have been installed at the midblock crossings extensively, fully functional Pelican

crossings are scarce due to a lack of proper management and placing and public awareness. The success of Pelican crossings is shown in studies from countries with extensive crossing networks where many reductions in pedestrian injuries have been recorded at these controlled crossings. However, the effectiveness of these crossing depends on the road users' awareness, utilization and compliance to the infrastructure that are not well-documented.

The study specifically focuses on two midblock crossings at Gwarko-Lamatar road section in Lalitpur.

1.2 Problem Statement

Walking safety has become an urgent public safety concern throughout Nepal's cities because of fast urban expansion coupled with rising vehicle numbers on roads. To do this, signal controlled pedestrian crossings, such as Pelican crossings, have been introduced to ease safety through management of pedestrian vehicle interactions. However, despite potential for these crossings to decrease pedestrian injuries and deaths, their effectiveness is limited due to low public awareness, user's non-compliance and low usage rates. Pedestrians may omit crossing or stop because of impatience or unfamiliarity about crossing protocols; drivers may often disobey pedestrian priority signals.

This study studies two key locations: one close to an educational institution together with another site located at a busy midblock section with significant pedestrian activity. Since introducing Pelican crossings alone is not going to ensure pedestrian safety unless there are public education campaigns and massive enforcement of proper use. However, since this technology is new to our cities, it is crucial to assess what road users understand and how they use it before expanding it further, which is what this study primarily focuses on. The insights obtained from this research could be used to refine the crossing designs, implement targeted public awareness campaigns, and project specific enforcement strategies to help create safer road-crossing behavior.

1.3 Objectives of Study

The study aimed to assess the pedestrian behavior at Pelican crossings. The specific objectives of the study are enlisted below:

- a) To understand the awareness the pedestrians hold of the Pelican crossing.
- b) Understanding the utilization patterns and identifying the significant factors that affect it.
- c) To assess the compliance levels of the pedestrians and comparing the impact of different factors.

1.4 Significance of Study

This study focused on the relationship between awareness, utilization, compliance and different variables. For instance, we discussed how the pedestrians might not comply with signals when they have to wait for a longer time or how they utilize it when the traffic volume varies. If we understand these sort of relations we can put more targeted interventions in place to improve overall pedestrian safety. The results provide the recommendations for improving pelican crossing and hence improving pedestrian safety. It could be the idea of infrastructure changes, and public awareness campaigns, or the increase in traffic enforcement. The wider research relating to road safety benefits from the study as it examines a new traffic safety intervention introduced in our context, which provides a relatively unique data source and observations to potentially guide other cities with similar issues.

1.5 Limitations of Study

- a) This study focuses on the assessment of the Pelican crossings just from the point of view of the pedestrians and not the vehicles.
- b) The study doesn't account for the differently abled / visually impaired people.
- c) The study doesn't cover for other various sites different from the selected ones like those in hospital areas due to them being nonfunctional during the course of study.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview

Research on pedestrian crossings behaviors at signalized intersections and at pedestrian crossings has identified a number of factors that affect compliance, utilization and awareness. Several factors affecting compliance, utilization, and awareness of pedestrian crossing behaviors at signalized intersections and pedestrian crossings have been the subject of research. The interaction between the road users has been studied mainly regarding the impacts produced by different attributes of the signal timing, and pedestrian demographics, and design elements. They also offer insights into behaviorally appropriate responses of pedestrians to crossing features and conditions that enhance or detract from compliance. This section provides a review of the current literature base that were used to assess pelican crossings, including in-depth analysis of the factors which affect utilization and signal adherence, and public awareness.

2.2 Binomial logistic regression

Binomial logistic regression is a statistical method used to model binary outcome variables. It is a regression analysis that predicts the probability of an event occurring, given a set of independent variables. Unlike linear regression, which predicts continuous values, logistic regression is used when the dependent variable is categorical, specifically a binary outcome (e.g., success/failure, yes/no, 0/1). The log-odds transformation ensures that probabilities remain within the range (0, 1).

For instance,

$Y_i = 1$ if the pedestrian utilized the pushbutton in an observation i while $Y_i = 0$ if the pedestrian didn't utilize the pushbutton. The equation (2.1) shows the binary logistic regression model.

$$\log \left(\frac{P(Y_i=1)}{P(Y_i=0)} \right) = \beta_0 + \beta_1 X_{i1} + \dots + \beta_k X_{ik} \quad (2.1)$$

Where, Y is the dependent variable,

X is the independent variable, β_0 is the intercept,

$\beta_1, \beta_2, \dots, \beta_k$ are the coefficients of each variable X_1, X_2, \dots, X_k .

The model's coefficients are interpreted in terms of odds ratios.

The exponentiated coefficient $\exp(\beta)$ represents the odds ratio (OR), which quantifies how the odds of the event occurring change with a one-unit change in independent variable. For example, the OR indicates how the odds of the dependent event (compliance) change with a one-unit increase in the independent variable (age).

OR > 1 signifies a positive relation i.e. an increase in X_i increases the odds of the event.,

OR < 1 signifies a negative relation i.e. an increase in X_i decreases the odds of the event.

OR=1 signifies X_i has no effect on the odds.

$[\exp(\beta)-1]*100$ gives the percentage (%) change in the odds of the event.

2.3 Summarized Literature

(Huang, 2001) Published a report that evaluated the effectiveness of illuminated pedestrian push buttons at four signalized intersections in Windsor, Ontario, using a before-and-after analysis of pedestrian behavior. The illuminated buttons, which light up when pressed to confirm activation, were found to have no statistically significant impact on key measures: button-pressing rates (16.9% before vs. 12.7% after), signal cycle activation (32% in both periods), or compliance with the walk signal (72.3% before vs. 67.8% after). While the buttons reduced unnecessary service calls (as pedestrians could visually confirm functionality), their small lights were often difficult to see, and they failed to address core reasons. Overall, the illuminated buttons offered minimal behavioral benefits but practical administrative advantages for municipalities.

(Ron Van Houten, 2006) conducted a study that evaluated the effects of pedestrian push-buttons that provide visual (LED light) and audible (tone) feedback when pressed. They wanted to determine if such feedback increases the proportion of pedestrians who press the button and subsequently wait for the "walk" signal before crossing. This study evaluated two busy intersections in Miami Beach. The results showed that the feedback significantly increased button-pressing rates (from 33.8% to 58.1% at one site and 40.3%

to 54.3% at another) and improved compliance with walk signals (from 51.2% to 72.5% and 72.3% to 86%, respectively).

Signalized crosswalks in a university campus environment were assessed by (Darcin Akin, 2007) for compliance rates based on spatial compliance (within crosswalk markings) temporal compliance (walking up to the signal) and overall compliance. They defined Temporal crossing compliance rates (TCCR), spatial crossing compliance rates (SCCR) and overall crossing compliance rates (OCCR) as:

$$SCCR = \frac{P^L}{P^{CIA}} \quad TCCR = \frac{P^T}{P^{CA}} \quad OCCR = \frac{P^{LT}}{P^{CIA}}$$

Where, P_i is the number of pedestrians (per hour) who comply with CA and pedestrian WALK signal,

P^{CIA} is the total number of the pedestrians (per hour) within CIA.

Their findings showed high spatial compliance (83.13%) but low temporal compliance (50.63%), with an overall compliance rate of 42.98%. The study emphasized that pedestrians may follow the crosswalk locations but disregard the signal timing, which indicates that improvements in signal timing and visibility need to be made to entice pedestrians for a safer crossing behavior

A study by (Nam Seok Kim, 2017) compared pedestrian push-button and pre-timed signal systems at midblock crossings through simulation analyses of two-, three-, and four-lane roads. The key findings revealed that push-button systems significantly reduced pedestrian delays in low pedestrian flow conditions, but became less effective as road width increased due to longer crossing times.. The researchers discussed the safety trade offs; while push-buttons reduced pedestrian jaywalking by 18% in low-flow scenarios, pre-timed signals prevented erratic vehicle braking in high-flow conditions.

In Kuala Lumpur, (Nursitihazlin Ahmad Termida, 2019) examined crossing behaviors from adult-child pairs at Pelican crossings. A series of Chi square (χ^2) analysis was performed to see whether there are differences in behavior displayed by pairs with varied age and gender of accompanied child. Their investigation of eight crossing behaviors like : looking left and right before crossing, crossing within the marked crosswalk, pressing the button to operate the lights, waiting for the 'green man' to appear before beginning to cross, as well as walking (not running) across the road, showed low compliance with important safety steps such as looking both ways before crossing. Gender differences were observed and found that girls walked carefully without running more often than boys due to boys being more impulsive in the traffic situation. The findings underscored

the importance of targeted pedestrian education, in particular, for young pedestrians, to reinforce correct crossing behaviors.

(Sia Mwendu, 2020) evaluated the two locations with high pedestrian activities equipped with traffic control signal at midblock crosswalks both being activated by the pushbuttons, in Dar Es Salaam, revealing low utilization, with only 21% of pedestrians using the pushbutton. Yet, signal interaction was correlated with compliance, as 83% of those who did use a pushbutton waited for the walk signal. The study looked at demographic impact, reporting that females (89% compliance rate) had higher rate of compliance compared to males (75%), and awareness of correct crossing procedures was low at 13%. For the analysis, they used binary logistic regression. This study displayed how demographic and awareness factors affect behavior at crossings.

A study by (Boniphace Kutela, 2020) evaluated factors influencing pedestrian pushbutton usage at signalized midblock crosswalks in Las Vegas, analyzing 2,407 crossing incidents across 20 locations. The major findings were that the first-arriving pedestrians were 7.85 times more likely to press the button than follow-up pedestrians, while males, children/teens, and the elderly showed lower usage rates. Flash-based signals (CRFBs/RRFBs) significantly outperformed traditional traffic signals, increasing pushbutton activation by 3.6–4.5 times. Infrastructure features like residential locations and multi-lane roads also promoted higher usage. Traffic conditions played a critical role, with higher vehicle speeds (>45 mph) and denser traffic nearly doubling the odds of button pressing.

(Putri, 2021) put forward a study that evaluated the performance of a demand-responsive Pelican crossing at midblock pedestrian facilities in Surakarta, Indonesia, comparing it to the existing fixed-time Pelican crossing. Using a calibrated VISSIM simulation model, the proposed system, based on Vehicle Actuated Control Extension Principle (VAC EP) logic, adjusts signal timing dynamically based on real-time traffic and pedestrian conditions. Results show that the demand-responsive Pelican crossing reduces average pedestrian delays by 9.7% to 14.1%, though it slightly increases vehicle delays by 1.0% to 4.7%. The adaptive signal timing improves pedestrian safety and compliance while maintaining traffic efficiency. This approach offered a promising solution for balancing pedestrian and vehicular needs at midblock crossings.

(Pritam Shah, 2023) explored the effect of countdown timers on pedestrian compliance at the Tripureshwor and Narayangopal intersections in Nepal. It compared pedestrian behavior for crossing the signalized intersection with and without the countdown timers.

Two regression models were developed for analysis. First, a binary logistic regression is run on the compliance and results indicate increased compliance with the presence of countdown timers of. Second, a multinomial regression for the pedestrian walking speed model (high, medium and low) is performed; their findings gave us that countdown timers increased compliance on average by 9.5%. Additionally, the model was validated to give 96% overall accuracy for cases including pedestrian signal countdown timer cases and 82% for without cases. The outcome of this was that by adding visual cues such as countdown timers, pedestrian behavior at signalized crossings might be enhanced, and crossings should more safely and more predictably.

(Eren Dağlı, 2024) studied pedestrian and driver behaviors at crosswalk with pedestrian push button signalization control in Samsun, Turkey and found 72.7% of the pedestrians to use the button, 27.3% not. Indeed, 21.1% of pedestrians seemed unaware of the system's purpose, evidence that public education might improve proper use. However, there was no such statistical modelling of one variable against another done in the paper. Instead, they have analyzed the behaviors based on pedestrian position (North and South axle), number of pedestrian, and behavior duration (waiting time for pedestrian). A higher traffic volume also affected pedestrian waiting times in their study, with overall compliance. Awareness campaigns could increase usage and safety of push button crosswalks, they suggested.

Since, there hasn't been a study on Pelican crossings in our context, there is a huge research gap which is the driving factor for this study. The study would be helpful to understand on what level the pedestrians understand and follow the crossings.

CHAPTER 3: METHODOLOGY

3.1 Research Design

The methodological framework, from data collection to model development, is illustrated in figure 3.1. The process begins with problem identification and the formulation of research questions. This is followed by selecting predictor variables and gathering data through questionnaire and video graphic survey. The collected data is then processed for model development, with a logistic regression model created using SPSS. To analyze pedestrian behavior, both utilization and compliance model are developed. Finally, the models are validated.

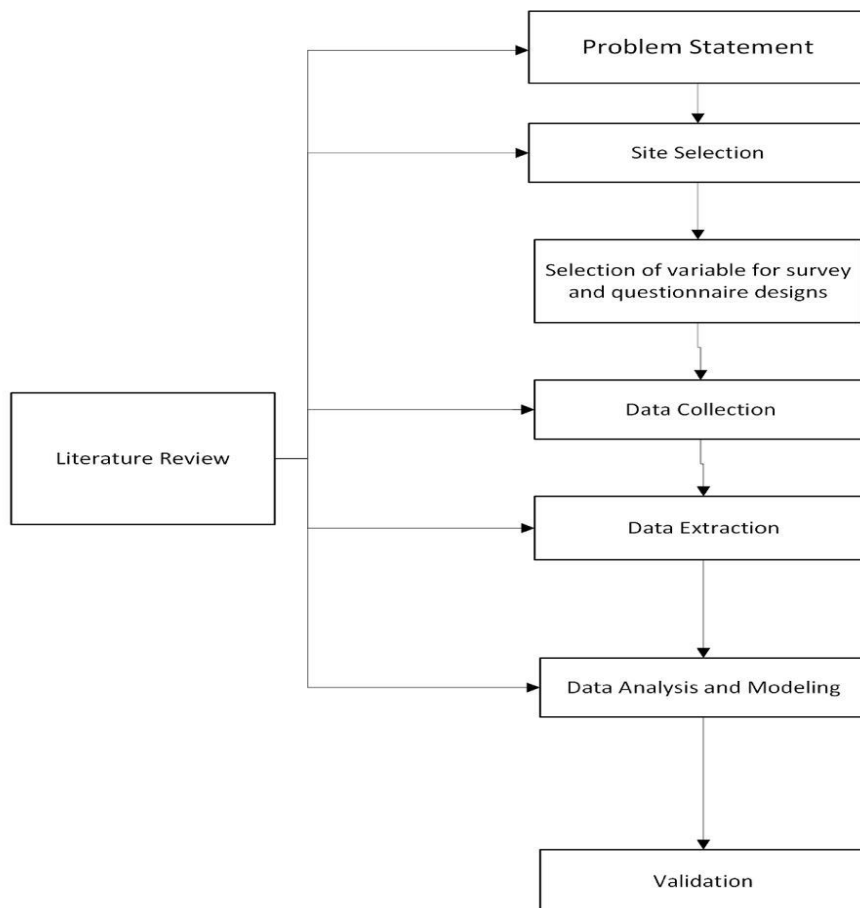


Figure 3.1 Framework of Research

3.2 Study Area

For the study purpose, a crossing in Imadol, nearby Krishna Mandir (Refer Figure 3.2) and another crossing nearby United School (Refer Figure 3.3) where the pushbuttons have been introduced by the Mahalaxmi Municipality in Gwarko-Lamatar road section in Lalitpur has been taken. This has been familiarized for around a year now which would be beneficial in getting the true insights of awareness, operation and obedience to the infrastructure.

The school-adjacent site was chosen due to the high volume of children crossing every day, making pedestrian safety a primary concern. The second location, while not directly at a major intersection, is placed along a high-traffic commuter corridor with multiple connecting roads and a mix of pedestrians, including office workers, shoppers, and local residents.

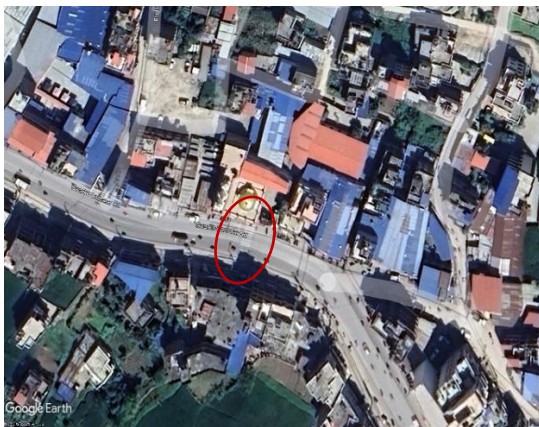


Figure 3.2 Site I: Krishna Mandir



Figure 3.3 Site II United School

3.3 Data Sampling

3.3.1 Sampling Technique

A stratified random sampling method was adopted for the questionnaire survey for the awareness modeling to ensure fair representation across different age groups, genders, and education levels. Stratified random sampling is a statistical technique used to ensure that different subgroups within a population are adequately represented in a study. This method is particularly valuable in studies where different subgroups may show distinct behaviors or traits, as it reduces variation and enhances the accuracy of estimates.

3.3.2 Sample Size Determination

Cochran's formula is a widely used method for determining an appropriate sample size in survey studies when the population is large or the exact size is unknown. It helps ensure that the sample is large enough to provide reliable estimates while avoiding the need to sample the entire population. The sample size can be calculated as using Cochran's formula given in (3.1):

$$n = \frac{z^2 p(1 - p)}{e^2} \quad (3.1)$$

Where, n= sample size

z= z value at reliability level or level of confidence

p = population proportion

e= precision level

For 95% level of confidence and 5% precision level, sample size is calculated as below:

z = 1.96 (For 95% level of confidence)

p = 0.5 (Considering maximum variability in heterogeneous population)

e = 0.05 (As precision level is 5%)

Then, sample size (n) = 384.

3.4 Data Collection

After defining the study area, the data was collected at two midblock crossings for 3 days for over an hour in the morning peak (9:00 AM-10:00 AM) and an hour in the evening peak time(4:00 PM-5:00 PM) by setting the video cameras at both the sites. The video graphic survey data was used for the utilization and compliance modelling.

The data for the awareness analysis were collected through questionnaire survey.

Refer to Appendix A for the sample questionnaire.

3.5 Data Extraction

The video recordings of the collected data were played and paused repeatedly in media player and extraction of data related to each variable was completed. The variables related to the pedestrians was determined through manual observation and estimation. The video footage was reviewed and thus the individuals were categorized into predefined age

groups, gender, based on visible characteristics such as facial features, body structure, posture, and walking style.

The variables extracted were:

- i. Age
- ii. Gender
- iii. Pedestrian group size,
- iv. Traffic volume,
- v. Waiting time,
- vi. Time of the day.

The classification of different categories of variables were done as shown in Table 3.1:

Table 3.1 Classification of variables

Waiting time	Up to 30 seconds 30 to 60 seconds 60 to 90 seconds 90 to 120 seconds	Can only be activated after 120 seconds, thus dividing maximum waiting time into four categories that would affect the compliance
Age	Children/Adolescents Young aged adults Middle aged adults Elderly	<20 years 20-39 years 40-59 years 60+ years
Pedestrian group size	Alone Small group Large group	2-3 people 3+ people
Traffic volume	High Low	The hourly volume is taken into account for this analysis.
Time of the day	Morning Evening	
Gender	Male Female	

a. Utilization data:

It was analyzed as an “event based utilization”. In this method, we count the utilization as *one*, regardless of the number of people crossing together, since *only one* pushbutton press initiated the event. The pushing or triggering of the buttons was seen as an event. This approach focuses on how often the crossing is being activated which is more relevant since the effectiveness of the crossing's signal system or infrastructure is being studied. However, “individual based utilization” might overstate the effectiveness as we cannot generalize or predict if the pedestrians crossing in a group would all utilize the pushbuttons.

b. Compliance data:

For the compliance data, the number of pedestrians who wait for the “green man signal” before crossing versus those who cross during the “red man signal” was observed and recorded.

c. Awareness data:

The questionnaire survey was a base for collection of data for the awareness analysis. The data was extracted to Microsoft Excel Sheet.

3.6 Data Analysis

For further data analysis and interpretation, IBM SPSS software was used. In SPSS, the binomial logistic regression was performed as suggested in (Sia Mwendu, 2020) since the choices of the dependent variables taken into account can be presented as a choice of yes/no or 0 and 1, and three different models for the awareness, utilization and compliance were analyzed. The variables considered for the modeling are shown in the

Table3.2 List of Variables

Dependent Variables	Independent Variables
Awareness	Age
	Gender
	Education level
	Usage

	Participation in awareness or educational campaigns
Utilization	Age
	Gender
	Pedestrian Group Size
	Traffic Volume
	Time of the day
Compliance	Age
	Waiting Time
	Gender
	Pedestrian Group Size
	Traffic Volume
	Time of the day

The descriptive statistics were also analyzed for the better understanding of these variables.

- **Selection of variables:**

1. Age:

Different age groups have varied crossing behaviors and risk perceptions.

- Younger pedestrians (children/adolescents) may have higher utilization and compliance due to school education.
- Elderly pedestrians may struggle with compliance due to slower walking speed, reduced mobility, and vision impairments.
- Prior research (Sia Mwende, 2020) shows age is a strong predictor of crossing compliance.

2. Gender:

Studies suggest gender differences in risk-taking behavior.

- Women are generally more risk-averse and likely to comply with pedestrian signals while men may exhibit more risky crossing behaviors (e.g., jaywalking).
- Previous research (Pritam Shah, 2023) found that women are more likely to follow pedestrian signals than men in Nepal.

3. Pedestrian group size:

Pedestrians crossing alone may behave differently than those in small or large groups.

- Large groups may feel safer in numbers and be more likely to comply.
- Individuals may jaywalk more often due to impatience.
- Prior studies (Eren Dağlı, 2024) suggest group size influences pedestrian compliance behavior.

4. Traffic volume:

Higher traffic volume increases pedestrian caution and compliance.

- Lower traffic volume may encourage jaywalking due to a perceived lack of danger.
- Research from Kuala Lumpur (Nursitihazlin Ahmad Termida, 2019) found that traffic density directly influences pedestrian compliance.

5. Waiting time:

- Longer waiting times reduce compliance because pedestrians become impatient.
- Pedestrians might cross on the red signal if the wait is perceived as too long.
- Previous studies (Rajja Shilpakar, 2022) show that compliance significantly drops after 60 seconds of waiting.

6. Usage:

- The pedestrians who are frequently using the pushbuttons crossings might be well familiarized as compared to those who use it occasionally.

7. Participation in awareness or educational campaigns:

- Having an active participation in educational campaigns would highly impact the level of awareness the pedestrians hold in comparison to those without any.

These independent variables were chosen because they are well-documented predictors of pedestrian behavior in international and Nepalese studies. They allow us to analyze how different demographic and situational factors influence utilization, compliance, and awareness at Pelican crossings.

3.7 Model formulation

3.7.1 Awareness model

The awareness model predicts the likelihood of pedestrian having the awareness of the traffic signals based on gender, age, education level, frequency of usage and participation in educational campaigns. The logistic regression formula for the awareness model is presented in equation (3.2).

$$\log\left(\frac{P(Y_i=1)}{P(Y_i=0)}\right) = \beta_0 + \beta_1 (\text{Gender}) + \beta_2 (\text{Age}) + \beta_3 (\text{education level}) + \beta_4 (\text{frequency of usage}) + \beta_5 (\text{participation in educational campaigns}). \quad (3.2)$$

The independent variables are categorical.

Selection of reference categories are done on the basis of the standard or largest group.

3.7.2 Utilization model

The utilization model predicts the likelihood of pedestrian utilization of the pushbuttons based on gender, age, time of day, pedestrian group size, and traffic volume. The logistic regression formula for the utilization model is presented in equation

(3.3):

$$\log\left(\frac{P(Y_i=1)}{P(Y_i=0)}\right) = \beta_0 + \beta_1(\text{Gender}) + \beta_2(\text{Age}) + \beta_3(\text{Time of the day}) + \beta_4(\text{Pedestrian group size}) + \beta_5(\text{Traffic volume}) \quad (3.3)$$

The independent variables are categorical.

3.7.3 Compliance model

The compliance model predicts the likelihood of pedestrian complying with the traffic signals based on gender, age, time of day, pedestrian group size, traffic volume and waiting time. The logistic regression formula for the compliance model is presented in equation (3.4).

$$\log\left(\frac{P(Y_i=1)}{P(Y_i=0)}\right) = \beta_0 + \beta_1(\text{Gender}) + \beta_2(\text{Age}) + \beta_3(\text{Time of the day}) + \beta_4(\text{Pedestrian group size}) + \beta_5(\text{Traffic volume}) + \beta_6(\text{Waiting time}) \quad (3.4)$$

The independent variables are categorical.

Selection of reference categories are done on the basis of the standard or largest group.

3.8 Model Validation

For model validation, the goodness of fit tests were done, classification tables were analyzed and R^2 values were checked.

1. Omnibus Tests of Model Coefficients:

This test is done to check whether the model is useful or not.

The following hypotheses are taken for the test:

H_0 : The model with predictors is not significantly better than the null model (i.e., all regression coefficients except the intercept are zero).

H₁: At least one predictor has a significant effect, meaning the model provides a better fit than the null model.

The test is based on Chi-square (χ^2) values. Degree of freedom (df) and significance values.

2. Hosmer and Lemeshow Test:

Hosmer and Lemeshow Test is done to check the goodness of fit of the model.

The hypotheses for this test are:

H₀: The model fits the data well (i.e., there is no significant difference between observed and predicted probabilities).

H₁: The model does not fit the data well.

The test is based on Chi-square (χ^2) values. Degree of freedom (df) and significance values.

3. Classification Table:

The classification table provides an evaluation of the logistic regression model's predictive performance. It compares the observed outcomes with the predicted outcomes.

CHAPTER 4: ANALYSIS, RESULTS AND DISCUSSION

4.1 Awareness

4.1.1 Descriptive Statistics

This section provides an overview of key demographic and behavioral variables, such as age groups, gender, education level, usage or familiarity and participation in awareness r educational campaigns in relation to pedestrians being aware and not aware. By visually representing the distribution of these variables using bar graphs, we can identify the preliminary patterns.

Out of all the total sampled pedestrians, 50.67% were found to be aware while 49.33% weren't aware about how the Pelican crossings worked.

The descriptive statistics of different variables are further shown below:

a. By Gender:

Table 4.1 shows how the awareness varies with the genders.

Table 4.1 Awareness * Gender Cross tabulation

Awareness * Gender Cross tabulation				
Count				
		Gender		Total
		Male	Female	
Awareness	Not Aware	129	125	254
	Aware	167	94	261
Total		296	219	515

b. By age groups:

Table 4.2 shows how the awareness varies with the different age groups.

Table 4.2 Awareness * Age Cross tabulation

Awareness * Age Cross tabulation						
Count						
		Age				Total
		Middle aged adults	Young aged adults	Children/Adolescents	Elderly	
Awareness	Not Aware	106	70	39	39	254
	Aware	51	74	110	26	261
Total		157	144	149	65	515

c. By education level:

Table 4.3 shows how the awareness varies with the education level of the pedestrians.

Table 4.3 Awareness * Education level Cross tabulation

Awareness * Education level Cross tabulation					
Count					
		Education level			Total
		High School	Below high school	Undergraduate or higher	
Awareness	Not Aware	107	47	100	254
	Aware	82	99	80	261
Total		189	146	180	515

d. By Frequency of usage or familiarity:

Table 4.4 shows how the awareness varies with how frequently the pedestrians use the crossings.

Table 4.4 Awareness *Frequency of Usage Cross tabulation

Awareness *Frequency of Usage Cross tabulation					
Count					
		Frequency of Usage			Total
		Several times a week	Daily	Occasionally	
Awareness	Not Aware	162	19	73	254
	Aware	103	133	25	261
Total		265	152	98	515

e. Participation in awareness/educational programs:

Table 4.5 shows how the awareness varies with the pedestrians attending some awareness/educational programs.

Table 4.5 Awareness * Participation in awareness/educational programs Cross tabulation

Awareness * Participation in awareness/educational programs Cross tabulation				
Count				
		Participation in awareness/educational programs		Total
		No	Yes	
Awareness	Not Aware	232	22	254
	Aware	117	144	261
Total		349	166	515

The conclusions that can be drawn on the basis of descriptive statistics are presented below:

Variables	Key Observations	Insights
Gender	Males: 167 Aware, 129 Not Aware - Females: 94 Aware, 125 Not Aware	Slightly higher awareness among males, but no extreme disparity
Age	- Highest awareness: Children/Adolescents (110) - Lowest awareness: Elderly (26)	Younger groups are more aware; middle-aged and elderly need targeted efforts
Education level	Highest awareness: Below high school (99) - Lowest awareness: High school (82)	Those below high school obtained the knowledge due to school programs.
Usage	Daily users: 133 Aware - Occasional users: 25 Aware	Frequent usage correlates strongly with awareness

Participation in educational programs	Participants: 144 Aware - Non-participants: 232 Not Aware	Programs are highly effective; non-participation is a major barrier.
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4.1.2 Logistic Regression Model

A binary logistic regression model was developed using the collected data to analyze the impact of various predictor variables on the awareness. Further considerations has been made for analysis, which are as follows:

- The pedestrian being aware was coded as 1
- The pedestrians who weren't aware were coded as 0

The variables were recoded into numeric form for the analysis in SPSS after being imported from the excel sheet. The recoding of the variables are shown in Table 4.6

Table 4.6 Recoding of the variables for awareness model

Age	Middle aged adults	1
	Young aged adults	2
	Children/Adolescents	3
	Elderly	4
Education level	High School	1
	Below High School	2
	Undergraduate or higher	3
Frequency of Usage	Several times a week	1
	Daily	2
	Occasionally	3
Participation in Awareness/educational programs	No	1
	Yes	2
Gender	Male	1
	Female	2

The data obtained showed the frequency of variables as shown in Table 4.7 on the basis of which the reference categories were further selected.

Table4.7 Frequency of variables for awareness

Variables		Frequency	Percentage
Age	Middle aged adults	157	30.49%
	Young aged adults	144	27.96%
	Children/Adolescents	149	28.93%
	Elderly	65	12.62%
Education level	High School	189	36.70%
	Below high school	146	28.35%
	Undergraduate or higher	180	34.95%
Frequency of usage	Several times a week	265	51.46%
	Daily	152	29.51%
	Occasionally	98	19.03%
Participation in awareness/ educational programs	No	349	67.77%
	Yes	166	32.23%
Gender	Male	296	57.48%
	Female	219	42.52%

Reference Categories:

The Table 4.8 briefs about the reference categories for the awareness model and why they were chosen.

Table 4.8 Reference categories for awareness model

Variables	Categories	Reference Category	Reason
Age	Children/ Adolescent, Young aged adults, Middle aged adults, Elderly	Middle aged adults	It is the largest category (157, 30.49%) and serves as a standard comparison.
Education level	High School Below high school Under- graduate or higher	High School	Most common category (189, 36.7%), useful as a baseline.
Frequency of usage	Several times a week Daily Occasionally	Several times a week	Majority category (265, 51.46%), easier to interpret results.
Participation in awareness/ educational programs	Yes, No	No	Larger group (67.7%)
Gender	Male, Female	Male	Largest category (296, 57.48%)

4.1.2.1 Model formulation

The awareness model was formulated using binary logistic regression method as shown in Table 4.9.

Table 4.9 Binary Logistic Regression Model for Awareness

Variables in the Equation				
	B	S.E.	Sig.	Exp(B)
Male				
Female	-0.546	0.231	0.018	0.579
Age			0.020	
Middle aged adults				
Young aged adults	0.733	0.294	0.013	2.081
Children/Adolescents	0.947	0.380	0.013	2.579
Elderly	-0.771	0.353	0.029	2.162
Education level			0.033	
High School				
Below high school	0.781	0.345	0.023	2.183
Undergraduate or higher	0.534	0.274	0.051	1.705
Frequency of usage			<0.001	
Several times a week				
Daily	1.670	0.318	<0.001	5.314
Occasionally	-0.535	0.288	0.063	0.585
No participation in awareness/educational programs				
Participation in awareness/educational programs	1.905	0.289	<0.001	6.719
Constant	-1.527	0.314	<0.001	0.217

The logistic regression model for the awareness model is presented in equation (4.1):

$$\log\left(\frac{P(Y_i=1)}{P(Y_i=0)}\right) = -1.527 - 0.546(\text{Female}) + 0.733(\text{Young aged adults}) + 0.947(\text{Children/Adolescent}) - 0.771(\text{Elderly}) + 0.781(\text{Below high school}) + 0.534(\text{Undergraduate or higher}) + 1.670(\text{Daily}) - 0.535(\text{Occasionally}) + 1.905(\text{Participation in awareness/educational programs}). \quad (4.1)$$

Interpretation of the coefficients:

1. Gender

Reference Category: Male

- Female: (B = -0.546, p = 0.018, Exp(B) = 0.579)

Females are 0.6 times less likely to be as aware compared to males. (p < 0.05).

2. Age Groups

Reference Category: Middle-aged Adults

- Young-aged Adults: (B = 0.733, p = 0.013, Exp(B) = 2.081)

Young adults are significantly more likely to be aware than middle-aged adults i.e. 2.081 times more likely (p < 0.05).

- Children/Adolescents: (B = 0.947, p = 0.013, Exp(B) = 2.579)

Children and adolescents are significantly about 2.6 times more likely to have the awareness than middle aged adults. (p < 0.05).

- Elderly: (B = -0.771, p = 0.029, Exp(B) = 0.462)

Elderly pedestrians are significantly less likely to have the knowledge of the crossings (0.462 times (53.8%) less likely)

3. Education Level

Reference Category: High School

- Below High School: (B = 0.781, p = 0.023, Exp(B) = 2.183)

Individuals with education below high school are significantly more likely to have the awareness with around 2.19 times of the likelihood (p < 0.05).

- Undergraduate or Higher: (B = 0.534, p = 0.051, Exp(B) = 1.705)

Higher education is associated with increased awareness, but it is only marginally significant (1.7 times more likely (p < 0.05).

4. Frequency of Usage

Reference Category: Several Times a Week

- Daily: (B = 1.670, $p < 0.001$, $\text{Exp}(B) = 5.314$)

Daily users are 5.314 times more likely to have the awareness of the crossings ($p < 0.001$, highly significant).

- Occasionally: (B = -0.535, $p = 0.063$, $\text{Exp}(B) = 0.585$)

Occasional users are less likely to have the awareness as compared to those who use the crossings several times a week.

5. Participation in Awareness/Educational Programs

Reference Category: No Participation Awareness/Educational Programs

- Participation in Awareness Programs: (B = 1.905, $p < 0.001$, $\text{Exp}(B) = 6.719$)
- Pedestrians who participated in awareness programs are significantly more likely to have the awareness about how and when to use the crossings. They are 6.719 times more likely ($p < 0.001$, highly significant).

6. Constant (Intercept)

(B = -1.527, $p < 0.001$, $\text{Exp}(B) = 0.217$)

- This represents the baseline odds of awareness when all predictors are at their reference category.

4.1.2.2 Model Validation

For the model validation, the goodness of fit tests was done, classification tables were analyzed and R^2 values were checked as mentioned in 3.8 Model Validation.

1. Omnibus Tests of Model Coefficients:

The Omnibus Test of Model Coefficients showed in Table 4.10 confirmed the model's statistical significance ($\chi^2=219.109$, $df=9$, $p<0.001$)

The hypotheses for the test are as discussed in Model Validation(1)

A low p-value (< 0.05) indicates that at least one predictor is significant as we reject the null hypothesis, so the model is useful.

Table 4.10 Omnibus Tests of Model Coefficients for Awareness model

		Chi-square (χ^2)	df	Significance.
Step 1	Step	219.109	9	<0.001
	Block	219.109	9	<0.001
	Model	219.109	9	<0.001

2. Hosmer and Lemeshow Test.

Since the p-value is greater than 0.05, as shown in Table 4.11 we fail to reject the null hypothesis, which is mentioned in Model Validation (2) suggesting that the logistic regression model provides a good fit to the data. This suggests that the predicted probabilities from the model align well with the actual outcomes, confirming the model's reliability in explaining the dependent variable.

Table 4.11 Hosmer and Lemeshow Test for Awareness model

Step	Chi-square (χ^2)	df	Significance.
1	8.959	7	0.256

3. Classification Table:

The classification table shown in table 4.12 provides an evaluation of the logistic regression for awareness model's predictive performance.

Table 4.12 Classification table for Awareness model

Classification Table				
Observed		Predicted		
		Awareness		Percentage Correct
		Not Aware	Aware	
Awareness	Not Aware	216	38	85
	Aware	78	183	70.1
Overall Percentage				77.5

It compares the observed outcomes (actual awareness vs. not aware) with the predicted outcomes. The model correctly classifies 85% of the not aware cases (216 out of 254) and 70.1% of the aware cases (78 out of 261). The overall classification accuracy is 77.5%, indicating that the model performs moderately well in distinguishing between aware and not aware cases.

The R^2 values are presented in the Table 4.13

Table 4.13 Model Summary of Awareness model

Model Summary				
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke Square	R
1	494.737	0.347	0.462	

4.2 Utilization

A logistic regression model was developed using the collected data to analyze the impact of various predictor variables on the dependent variable. Further considerations has been made for analysis, which are as follows:

- Utilization was coded as 1
- Non utilization was coded as 0

The variables were recoded into numeric form for the analysis in SPSS after being imported from the excel sheet. The recoding of the variables are shown in Table 4.14.

Table 4.14 Recoding of the variables (Utilization)

Age	Children/Adolescents	1
	Young aged adults	2
	Middle aged adults	3
	Elderly	4
Pedestrian group size	Alone	1
	Small group	2
	Large group	3
Traffic volume	High	1
	Low	2
Time of the day	Morning	1
	Evening	2
Gender	Male	1
	Female	2

4.2.1 Site I: Krishna Mandir, Imadol

The descriptive statistics of the utilization patterns across various independent variables are discussed in the Appendix B.

The data obtained for the Site I showed the frequency of variables as shown in Table 4.15. on the basis of which the reference categories were further selected.

Table 4.15 Frequency of the variables at site I (Utilization)

	Variables	Frequency	Percentage
Age	Young aged adults	217	54.52%
	Children/Adolescents	25	6.28%
	Middle aged adults	123	30.90%
	Elderly	33	8.29%
Pedestrian group size	Alone	210	52.76%
	Small group	168	42.21%
	Large group	20	5.03%
Traffic volume	High	346	86.93%
	Low	52	13.07%
Time of the day	Morning	223	56.03%
	Evening	175	43.97%
Gender	Male	205	51.51%
	Female	193	48.49%

4.2.1.1 Model formulation

The utilization model was formulated using binary logistic regression method as shown in Table 4.16

Table 4.16 Logistic Regression Model for Utilization behavior for site I (Utilization)

Variables in the Equation				
	B	S.E.	Sig.	Exp(B)
Male				
Female	0.462	0.225	0.040	1.587
Age			0.003	
Young aged adults				
Children/Adolescents	0.912	0.529	0.085	2.488
Middle aged adults	-0.138	0.250	0.582	0.871
Elderly	-1.326	0.417	0.001	0.265
Morning				
Evening	0.141	0.224	0.530	1.151
Pedestrian group size			0.015	
Alone				
Small group	-0.604	0.239	0.011	0.546
Large group	-0.966	0.488	0.048	0.381
High Traffic volume				
Low Traffic volume	-1.681	0.345	<0.001	0.186
Constant	0.798	0.218	<0.001	2.222

All the variables were found to be significant except the time of the day.

The logistic regression model for the utilization model is presented in equation (4.2)

$$\log\left(\frac{P(Y_i=1)}{P(Y_i=0)}\right) = 0.798 + 0.462(\text{Female}) + 0.912(\text{Children/Adolescents}) - 0.138(\text{Middle-aged adults}) - 1.326(\text{Elderly}) - 0.604(\text{Small group}) - 0.966(\text{Large group}) - 1.681(\text{Low traffic volume}) \quad (4.2)$$

Interpretation of Coefficients:

1. Gender

Female (B = 0.462, p = 0.040, Exp(B) = 1.587):

The females are 1.587 times more likely to engage in the utilization of the pushbuttons as compared to males.

The p-value (0.040) shows statistical significance, meaning gender has a meaningful effect.

2. Age Groups

a. Children/Adolescents ($B = 0.912$, $p = 0.085$, $\text{Exp}(B) = 2.488$):

The odds of children/adolescents utilizing are 2.488 times higher than young-aged adults.

b. Middle-aged adults ($B = -0.138$, $p = 0.582$, $\text{Exp}(B) = 0.871$):

This group is slightly 0.871 less likely to utilize than young-aged adults, but the effect is marginally significant ($p = 0.582$).

c. Elderly ($B = -1.326$, $p = 0.001$, $\text{Exp}(B) = 0.265$):

The elderly individuals are 0.266 times less likely to engage in the utilization of the pushbuttons as compared to the young adults.

3. Pedestrian Group Size

a. Small group ($B = -0.604$, $p = 0.011$, $\text{Exp}(B) = 0.546$):

Those pedestrians crossing in the small groups are 0.546 times less likely to utilize the pushbuttons than those crossing alone.

b. Large group ($B = -0.966$, $p = 0.048$, $\text{Exp}(B) = 0.381$):

Those pedestrians crossing in the large groups are 0.381 times less likely to utilize the pushbuttons than those crossing alone.

4. Traffic Volume

Low traffic volume ($B = -1.681$, $p < 0.001$, $\text{Exp}(B) = 0.186$):

In areas with low traffic volume, utilization of the pushbuttons is significantly reduced

The odds of utilization are 0.186 times (81.4%) lesser that of high-traffic volume areas.

5. Constant ($B = 0.798$, $p < 0.001$, $\text{Exp}(B) = 2.222$)

The constant represents the baseline log-odds of utilization when all predictor variables are at their reference category. This means that under these conditions, the odds of utilizing are 2.222 times greater than not utilizing. When the individual is male, a young adult, walking alone, and in high traffic conditions, the odds of utilization are 2.222.

4.2.1.2 .Model Validation

For the model validation, the goodness of fit tests was done, classification tables were analyzed and R^2 values were checked as mentioned in 3.8 Model Validation.

The tables of the model validation are presented in Appendix C.

4.2.2 Site II: United School, Gwarko-Lamatar road

The descriptive statistics of the utilization patterns across various independent variables are discussed in the Appendix B.

The data obtained for the Site II showed the frequency of variables as shown in Table 4.17. on the basis of which the reference categories were further selected.

Table 4.17 Frequency of the variables at site II (Utilization)

Variables		Frequency	Percentage
Age	Children/Adolescents	164	33.40%
	Young aged adults	160	32.59%
	Middle aged adults	147	29.94%
	Elderly	20	4.07%
Pedestrian group size	Alone	249	50.71%
	Small group	186	37.88%
	Large group	56	11.41%
Traffic volume	High	424	86.35%
	Low	67	13.65%
Time of the day	Morning	257	52.34%
	Evening	234	47.66%
Gender	Male	277	56.42%
	Female	214	43.58%

4.2.2.1 Model Formulation

The utilization model was formulated using binary logistic regression method as shown in Table 4.18.

Table 4.18 Logistic Regression Model for Utilization behavior for site II (Utilization)

Variables in the Equation				
	B	S.E.	Sig.	Exp(B)
Male				
Female	0.380	0.194	0.051	1.462
Age			0.022	
Children/Adolescents				
Young aged adults	-0.534	0.237	0.024	0.586
Middle aged adults	-0.347	0.245	0.156	0.707
Elderly	-1.369	0.527	0.009	0.254
Morning				
Evening	-0.159	0.192	0.408	0.853
Pedestrian group size			0.006	
Alone				
Small group	-0.607	0.205	0.003	0.545
Large group	-0.616	0.312	0.048	0.540
High Traffic volume				
Low Traffic volume	-0.620	0.275	0.024	0.538
Constant	0.972	0.242	<0.001	2.644

All the variables were found to be significant except the time of the day.

The logistic regression model for the utilization model is presented in equation (4.3)

$$\log \left(\frac{P(Y_i=1)}{P(Y_i=0)} \right) = 0.972 + 0.380(\text{Female}) - 0.534$$

$$(\text{Young adults}) - 0.347 (\text{Middle-aged adults}) - 1.369 (\text{Elderly}) -$$

$$0.607(\text{Small group}) - 0.616(\text{Large group}) - 0.620(\text{Low traffic v$$

$$\text{olume}) \quad (4.3)$$

Interpretation of Coefficients:

1. Gender

Female (B = 0.380, p = 0.051, Exp(B) = 1.462):

The females are 1.462 times more likely to engage in the utilization of the pushbuttons as compared to males..

2. Age Groups

a. Young aged adults ($B = -0.534$, $p = 0.024$, $\text{Exp}(B) = 0.586$):

The odds of young aged adults utilizing are 0.586 times than children/adolescents.

b. Middle-aged adults ($B = -0.347$, $p = 0.156$, $\text{Exp}(B) = 0.707$):

This group is slightly 0.707 times less likely to utilize than children/adolescents.

c. Elderly ($B = -1.369$, $p = 0.009$, $\text{Exp}(B) = 0.254$):

The elderly individuals are 0.254 times less likely to engage in the utilization of the pushbuttons as compared to the children/adolescents.

3. Pedestrian Group Size

a. Small group ($B = -0.607$, $p = 0.003$, $\text{Exp}(B) = 0.545$):

Those pedestrians crossing in the small groups are 0.545 times less likely to utilize the pushbuttons than those crossing alone.

b. Large group ($B = -0.616$, $p = 0.048$, $\text{Exp}(B) = 0.540$):

Those pedestrians crossing in the large groups are 0.540 times less likely to utilize the pushbuttons than those crossing alone.

4. Traffic Volume

Low traffic volume ($B = -0.620$, $p < 0.024$, $\text{Exp}(B) = 0.538$):

In areas with low traffic volume, utilization of the pushbuttons is significantly reduced

The odds of utilization are 0.538 times (46.2%) lesser that of high-traffic volume areas.

5. Constant ($B = 0.792$, $p < 0.001$, $\text{Exp}(B) = 2.644$)

The constant represents the baseline log-odds of utilization when all predictor variables are at their reference category.

4.2.2.2 Model Validation

For the model validation, the goodness of fit tests was done, classification tables were analyzed and R^2 values were checked as mentioned in 3.8 Model Validation.

The tables of the model validation are presented in Appendix C.

4.2.3 Combined Utilization Model

Since, both the sites showed similar results in terms of the independent variables without much difference, the data from both the sites were combined and a final binary logistic regression model was developed for the assessment of the utilization patterns of the pushbuttons of the pedestrians

4.2.3.1 Descriptive Statistics

This section provides an overview of key demographic and behavioral variables, such as age groups, gender, pedestrian group size, and traffic conditions, in relation to utilization and non-utilization. By visually representing the distribution of these variables using bar graphs, we can identify the preliminary patterns.

Out of all the total sampled pedestrians, 59.62% were found to be utilizing the pushbutton infrastructure while 40.38% were found to be not using it

The descriptive statistics of different variables are further shown below:

a. By Gender:

Table 4.19 shows how the utilization of pushbuttons varies with the gender.

Table 4.19 Utilization * Gender Cross tabulation

Utilization * Gender Cross tabulation				
Count				
		Gender		Total
		Male	Female	
Utilization	Non utilization	214	145	359
	Utilization	268	262	530
Total		482	407	889

b. By Age groups:

Table 4.20 shows how the utilization of pushbuttons varies with the age groups.

Table 4.20 Utilization * Age Cross tabulation

Utilization * Age Cross tabulation						
Count						
		Age				Total
		Young aged adults	Children/ Adolescents	Middle aged adults	Elderly	
Utilization	Non utilization	153	59	112	35	359

	Utilization	224	130	158	18	530
Total		377	189	270	53	889

c. By Pedestrian group size:

Table 4.21 shows how the utilization of pushbuttons varies with the pedestrian group size.

Table 4.21 Utilization*Pedestrian Group Size Cross tabulation

Utilization * Pedestrian Group Size Cross tabulation					
Count					
		Pedestrian Group Size			Total
		Alone	Small group	Large group	
Utilization	Non utilization	160	164	35	359
	Utilization	299	190	41	530
Total		459	354	76	889

d. By Traffic Volume:

Table 4.22 shows how the utilization of pushbuttons varies with the traffic volume.

Table 4.22 Utilization * Traffic volume Cross tabulation

Utilization * Traffic volume Cross tabulation				
Count				
		Traffic volume		Total
		High Traffic volume	Low Traffic volume	
Utilization	Non Utilization	284	75	359
	Utilization	486	44	530
Total		770	119	889

e. By time of the day:

Table 4.23 shows how the utilization of pushbuttons varies with the the time of the day.

Table 4.23 Utilization * Time of the day Cross tabulation

Utilization * Time of the day Cross tabulation				
Count				
		Time of the day		Total
		Morning	Evening	
Utilization	Non Utilization	190	169	359
	Utilization	290	240	530
Total		480	409	889

The conclusions that can be drawn on the basis of descriptive statistics are presented below:

Variables	Key Observations	Insights
Gender	Male: 268 Utilization, 214 Non-Utilization - Female: 262 Utilization, 145 Non-Utilization	Slightly higher utilization of pushbuttons by females
Age	- Highest utilization: Young aged adults(224) - Lowest: Elderly (18)	Younger groups utilised the pushbuttons more frequently.
Pedestrian group size	Highest utilization: Alone (299) - Large group(41)	Individuals alone are most likely to utilise. Group size inversely correlates with utilization.
Traffic volume	High Traffic: 486 Utilization, - Low Traffic: 44 Utilization,	Utilization is overwhelmingly linked to high-traffic volumes.

		Low-traffic volumes see minimal use
Time of the day	Morning: 290 Utilization, - Evening: 240 Utilization	Higher utilization in mornings.

4.2.3.2 Logistic Regression Model

The data obtained showed the frequency of variables as shown in Table 4.24.

Table 4.24 Frequency of variables for utilization

Variables		Frequency	Percentage
Age	Young aged adults	377	42.41%
	Children/Adolescents	189	21.26%
	Middle aged adults	270	30.37%
	Elderly	53	5.96%
Pedestrian Group Size	Alone	459	51.63%
	Small group	354	39.82%
	Large group	76	8.55%
Traffic volume	High Traffic volume	770	86.61%
	Low Traffic volume	119	13.39%
Time of the day	Morning	480	53.99%
	Evening	409	46.01%
Gender	Male	482	54.22%
	Female	407	45.78%

Reference categories:

The Table 4.25 briefs about the reference categories for the utilization model and why they were chosen.

Table 4.25 Reference categories for utilization model

Variable	Categories	Reference Category	Reason
Age	Children/ Adolescent, Young aged adults, Middle aged adults, Elderly	Young aged adults	It is the largest category (377) and serves as a standard comparison.
Pedestrian Group Size	Alone, Small group, Large group	Alone	Most common category (459), useful as a baseline.
Traffic Volume	High, Low	High	Majority category (770), easier to interpret results.
Time of the Day	Morning, Evening	Morning	Larger group (480).
Gender	Male, Female	Male	Conventionally used in research and is slightly larger (482).

The utilization model was formulated using binary logistic regression method as shown in Table 4.26.

Table 4.26 Binary Logistic Regression Model for Utilization

Variables in the Equation				
	B	S.E.	Sig.	Exp(B)
Male				
Female	0.386	0.144	0.008	1.471
Age			<0.001	
Young aged adults				
Children/ Adolescents	0.416	0.195	0.032	1.516
Middle aged adults	0.022	0.169	0.896	1.022
Elderly	-1.092	0.319	0.001	0.335
Morning				
Evening	-0.032	0.144	0.823	0.968
Pedestrian Group Size			0.001	
Alone				
Small group	-0.564	0.151	<0.001	0.569
Large group	-0.517	0.260	0.046	0.596
High Traffic volume				
Low Traffic volume	-1.069	0.211	<0.001	0.343
Constant	0.629	0.157	<0.001	1.876

All the variables except the time of the day were found to be significant.

The logistic regression model for the utilization model is presented in equation (4.3):

$$\log\left(\frac{P(Y_i=1)}{P(Y_i=0)}\right) = 0.629 + 0.386(\text{Female}) + 0.416(\text{Children/Adolescents}) + 0.002(\text{Middle-aged adults}) - 1.092(\text{Elderly}) - 0.564(\text{Small group}) - 0.517(\text{Large group}) - 1.069(\text{Low traffic volume}) \quad (4.4)$$

Interpretation of the coefficients:

1. Gender

Female ($B = 0.386$, $p = 0.008$, $\text{Exp}(B) = 1.471$):

The females are 1.471 times more likely to engage in the utilization of the pushbuttons as compared to males.

The p-value (0.008) shows statistical significance, meaning gender has a meaningful effect.

2. Age Groups

($p < 0.001$, highly significant)

a. Children/Adolescents ($B = 0.416$, $p = 0.032$, $\text{Exp}(B) = 1.516$):

The odds of children/adolescents utilizing are 1.516 times higher than young-aged adults.

b. Middle-aged adults ($B = 0.022$, $p = 0.896$, $\text{Exp}(B) = 1.022$):

There isn't much difference in the utilization patterns of middle aged and young aged adults.

c. Elderly ($B = -1.092$, $p = 0.001$, $\text{Exp}(B) = 0.335$):

The elderly individuals are 0.335 times less likely to engage in the utilization of the pushbuttons as compared to the young adults.

3. Pedestrian Group Size

a. Small group ($B = -0.564$, $p < 0.001$, $\text{Exp}(B) = 0.569$):

Those pedestrians crossing in the small groups are 0.569 times less likely to utilize the pushbuttons than those crossing alone.

b. Large group ($B = -0.517$, $p = 0.046$, $\text{Exp}(B) = 0.596$):

Those pedestrians crossing in the large groups are 0.596 times less likely to utilize the pushbuttons than those crossing alone.

4. Traffic Volume

Low traffic volume ($B = -1.069$, $p < 0.001$, $\text{Exp}(B) = 0.343$):

In areas with low traffic volume, utilization of the pushbuttons is significantly reduced

The odds of utilization are 0.343 times (65.7%) lesser that of high-traffic volume areas.

5. Constant ($B = 0.629$, $p < 0.001$, $\text{Exp}(B) = 1.876$)

The constant represents the baseline log-odds of utilization when all predictor variables are at their reference category. This means that under these conditions, the odds of utilizing are 2.33 times greater than not utilizing. When the individual is male, a young adult, walking alone, and in high traffic conditions, the odds of utilization are 1.876.

Model Validation:

For the model validation, the goodness of fit tests was done, classification tables were analyzed and R^2 values were checked as mentioned in 3.8 Model Validation.

1. Omnibus Tests of Model Coefficients:

The hypotheses for the test are as discussed in Model Validation(1)

A low p-value (< 0.05) indicates that at least one predictor is significant as we reject the null hypothesis, so the model is useful

Table 4.27 Omnibus Test for utilization model

Omnibus Tests of Model Coefficients				
		Chi-square (χ^2)	df	Significance
Step 1	Step	69.834	8	<0.001
	Block	69.834	8	<0.001
	Model	69.834	8	<0.001

2. Hosmer and Lemeshow Test

Since the p-value is greater than 0.05, as shown in Table 4.28 we fail to reject the null hypothesis, which is mentioned in Model Validation (2) suggesting that the logistic regression model provides a good fit to the data. This suggests that the predicted probabilities from the model align well with the actual outcomes, confirming the model's reliability in explaining the dependent variable.

Table 4.28 Hosmer and Lemeshow Test for Utilization model

Hosmer and Lemeshow Test			
Step 1	Chi-square (χ^2)	df	Significance.
	3.533	8	0.897

3. Classification Table

The classification table shown in Table 4.29 provides an evaluation of the logistic regression for utilization model's predictive performance.

Table 4.29: Classification Table for Utilization model

Classification Table ^a				
Observed		Predicted		
		Utilization		Percent age Correct
		Non utilizatio n	Utilizatio n	
Utiliz ation	Non utilization	98	261	27.3
	Utilizatio n	59	471	88.9
Overall Percentage				64.0

It compares the observed outcomes (actual utilization vs. non-utilization) with the predicted outcomes. The model correctly classifies 27.3% of the non-utilization cases (98 out of 261) and 88.9% of the utilization cases (59 out of 471). The overall classification accuracy is 64%, indicating that the model performs moderately well in distinguishing between utilization and non-utilization.

The R^2 values are presented in the Table 4.30

Table 4.30 Model Summary of Utilization for Site

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	485.236	0.086	0.102

4.3 Compliance

A logistic regression model was developed using the collected data to analyze the impact of various predictor variables on the dependent variable. Further considerations has been made for analysis, which are as follows:

- Compliance was coded as 1
- Noncompliance was coded as 0

The variables were recoded into numeric form for the analysis in SPSS after being imported from the excel sheet. The recoding of the variables are shown in Table 4.31..

Table 4.31 Recoding of the variables (Compliance)

Age	Young aged adults	1
	Children/Adolescents	2
	Middle aged adults	3
	Elderly	4
Pedestrian group size	Small group	1
	Alone	2
	Large group	3
Traffic volume	High	1
	Low	2
Time of the day	Evening	1
	Morning	2
Gender	Female	1
	Male	2
Waiting time	Up to 30 seconds	1
	30 to 60 seconds	2
	60 to 90 seconds	3
	90 o 120 seconds	4

4.3.1 Site I: Krishna Mandir, Imadol

The descriptive statistics of the compliance across various independent variables are discussed in the Appendix B.

The data obtained for the Site I showed the frequency of variables as shown in Table 4.32 on the basis of which the reference categories were further

Table 4.32 Frequency of the variables at site I (Compliance)

Variables		Frequency	Percentage
Waiting time	Up to 30 seconds	657	56.30%
	30 to 60 seconds	340	29.13%
	60 to 90 seconds	143	12.25%
	90 to 120 seconds	27	2.31%
Age	Young aged adults	616	52.78%
	Children/ Adolescents	126	10.80%
	Middle aged adults	356	30.51%
	Elderly	69	5.91%
Pedestrian group size	Small group	510	43.70%
	Alone	269	23.05%
	Large group	388	33.25%
Time of the day	Evening	725	62.13%
	Morning	442	37.87%
Traffic volume	High	1076	92.20%
	Low	91	7.80%
Gender	Female	624	53.47%
	Male	543	46.53%

4.3.1.1 Model formulation

The compliance model was formulated using binary logistic regression method as shown in Table 4.33

Table 4.33 Logistic Regression Model for Compliance behavior for site I

Variables in the Equation				
	B	S.E.	Sig.	Exp(B)
Female				
Male	-0.219	0.160	0.171	0.804
Age			0.013	
Young aged adults				
Children/Adolescent	0.639	0.352	0.069	1.895
Middle aged adults	0.140	0.180	0.436	1.150
Elderly	-0.682	0.294	0.020	0.506
Evening				
Morning	0.570	0.170	0.001	1.768
Pedestrian group size			<0.001	
Small group				
Alone	-0.879	0.176	<0.001	0.415
Large group	1.515	0.247	<0.001	4.551
High Traffic volume				
Low Traffic volume	-0.534	0.266	0.044	0.586
Waiting time			<0.001	
Up to 30 seconds				
30 to 60 seconds	-0.093	0.191	0.625	0.911
60 to 90 seconds	-0.961	0.232	<0.001	0.383
90 to 120 seconds	-2.071	0.476	<0.001	0.126
Constant	1.438	0.184	<0.001	4.213

The logistic regression model for the compliance model is presented in equation (4.5)

$$\log\left(\frac{P(Y_i=1)}{P(Y_i=0)}\right) = 1.438 - 0.219(\text{Male}) + 0.639(\text{Children/Adolescent}) + 0.14(\text{Middle-aged adults}) - 0.682(\text{Elderly}) + 0.570(\text{Morning}) - 0.879(\text{Alone}) + 1.515(\text{Large group}) - 0.534(\text{Low traffic volume}) - 0.093(30 \text{ to } 60 \text{ seconds}) - 0.961(60 \text{ to } 90 \text{ seconds}) - 2.071(90 \text{ to } 120 \text{ seconds}) \quad (4.5)$$

Interpretation of Coefficients:

1. Gender

Reference Category: Female

Male: (B = -0.219, p = 0.171, Exp(B) = 0.804)

Males are 0.804 times less likely than females to comply to the crossing, but the result is not statistically significant (p > 0.05).

2. Age Groups

Reference Category: Young aged adults

- Children/Adolescents: (B = 0.639, p = 0.069, Exp(B) = 1.895)

Children/adolescents are 1.895 times more likely comply to the crossing than young adults, but this result is only marginally significant (p = 0.069).

- Middle-aged Adults: (B = 0.140, p = 0.436, Exp(B) = 1.150)

No significant difference from young adults (p > 0.05).

- Elderly: (B = -0.682, p = 0.020, Exp(B) = 0.506)

Elderly pedestrians are significantly less likely to comply to the crossing as compared to young adults (p < 0.05). The compliance decreases hugely by 49.4%

3. Time of Day

Reference Category: Evening

Morning: (B = 0.570, p = 0.001, Exp(B) = 1.768)

The pedestrians using the infrastructure in the morning are significantly 1.768 times more likely to comply to the crossing than those in the evening.

4. Pedestrian Group Size

Reference Category: Small group

- Alone: (B = -0.879, $p < 0.001$, $\text{Exp}(B) = 0.415$)

The alone commuters are significantly 0.415 times less likely to comply to the crossing than those in small groups.

- Large Group: (B = 1.515, $p < 0.001$, $\text{Exp}(B) = 4.551$)

Large groups are significantly 4.551 times more likely to comply due to the sense of safety or/and due to the peer pressure.

5. Traffic Volume

Reference Category: High Traffic Volume

- Low Traffic Volume: (B = -0.534, $p = 0.044$, $\text{Exp}(B) = 0.586$)

Pedestrians in low traffic volume areas are 0.586 times less likely to comply to the crossing as they might feel quite safer to cross.

6. Waiting Time

Reference Category: Up to 30 seconds

- 30 to 60 seconds: (B = -0.093, $p = 0.625$, $\text{Exp}(B) = 0.911$)

No significant effect ($p = 0.625$), but a slight decrease of 8.9% in likelihood.

- 60 to 90 seconds: (B = -0.961, $p < 0.001$, $\text{Exp}(B) = 0.383$)

. Pedestrians waiting 60–90 seconds are 61.7% less likely to wait and comply to the signals.).

- 90 to 120 seconds: (B = -2.071, $p < 0.001$, $\text{Exp}(B) = 0.126$)

Pedestrians waiting 90–120 seconds are the least likely to comply to the crossings The compliance greatly reduces by 87.4% when the pedestrians had to wait for 90 to 120 seconds.

7. Constant (Intercept)

(B = 1.438, $p < 0.001$, $\text{Exp}(B) = 4.213$)

This represents the baseline odds of the behavior occurring when all predictors are at their reference category

4.3.1.2 Model Validation

For the model validation, the goodness of fit tests was done, classification tables were analyzed and R^2 values were checked as mentioned in 3.8 Model Validation.

The tables of the model validation are presented in Appendix C.

4.3.2 Site II: United School, Gwarko-Lamatar road

The descriptive statistics of the compliance across various independent variables are discussed in the Appendix B.

The data obtained for the Site I showed the frequency of variables as shown in Table 4.34 on the basis of which the reference categories were further

Table 4.34 Frequency of the variables at site II (Compliance)

Variables		Frequency	Percentage
Waiting time	Up to 30 seconds	710	56.66%
	30 to 60 seconds	359	28.65%
	60 to 90 seconds	150	11.97%
	90 to 120 seconds	34	2.71%
Age	Young aged adults	616	49.16%
	Children/Adolescents	219	17.48%
	Middle aged adults	347	27.69%
	Elderly	71	5.67%
Pedestrian group size	Small group	550	43.89%
	Alone	297	23.70%
	Large group	406	32.40%
Time of the day	Morning	727	58.02%
	Evening	526	41.98%
Traffic volume	High	1167	93.14%
	Low	86	6.86%
Gender	Female	673	53.71%
	Male	580	46.29%

4.3.2.1 Model formulation

The compliance model was formulated using binary logistic regression method as shown in Table 4.35

Table 4.35 Logistic Regression Model for Compliance behavior for site II

Variables in the Equation				
	B	S.E.	Sig.	Exp(B)
Female				
Male	-0.314	0.152	0.039	0.731
Age			0.001	
Young aged adults				
Children/Adolescents	0.680	0.246	0.006	1.975
Middle aged adults	0.124	0.177	0.481	1.133
Elderly	-0.651	0.283	0.021	0.522
Morning				
Evening	-0.316	0.154	0.041	0.729
Pedestrian group size			<0.001	
Small group				
Alone	-0.752	0.167	<0.001	0.471
Large group	1.205	0.219	<0.001	3.336
High Traffic volume				
Low Traffic volume	-0.843	0.260	0.001	0.431
Waiting time			<0.001	
Up to 30 seconds				
30 to 60 seconds	-0.054	0.183	0.766	0.947
60 to 90 seconds	-1.085	0.218	<0.001	0.338
90 to 120 seconds	-1.798	0.405	<0.001	0.166
Constant	1.785	0.182	<0.001	5.959

The logistic regression model for the compliance model is presented in equation (4.3):

$$\log\left(\frac{P(Y_i=1)}{P(Y_i=0)}\right) = 1.785 - 0.314(\text{Male}) + 0.68(\text{Children/Adolescent}) + 0.124(\text{Middle-aged adults}) - 0.651(\text{Elderly}) - 0.316(\text{Evening}) - 0.752(\text{Alone}) + 1.205(\text{Large group}) - 0.843(\text{Low traffic volume}) - 0.054(30 \text{ to } 60 \text{ seconds}) - 1.085(60 \text{ to } 90 \text{ seconds}) - 1.798(90 \text{ to } 120 \text{ seconds}) \quad (4.6)$$

Interpretation of Coefficients:

1. Gender

Reference Category: Female

Male: (B = -0.314, p = 0.039, Exp(B) = 0.731)

Males are 0.731 times less likely than females to comply to the crossing, but the result is not statistically significant (p > 0.05)..

2. Age Groups

Reference Category: Young aged adults

- Children/Adolescents: (B = 0.680, p = 0.006, Exp(B) = 1.975)

Children/adolescents are 1.975 times more likely comply to the crossing than young adults.

- Middle-aged Adults: (B = 0.124, p = 0.481, Exp(B) = 1.133)

No significant difference from young adults (p > 0.05).

- Elderly: (B = -0.651, p = 0.021, Exp(B) = 0.522)

Elderly pedestrians are significantly 0.522 times less likely to comply to the crossing as compared to young adults (p < 0.05). The compliance decreases hugely by 47.8%

3. Time of Day

Reference Category: Morning

- Evening: (B = -0.316, p = 0.041, Exp(B) = 0.729)

The pedestrians using the infrastructure in the evening are significantly 0.729 times less likely to comply to the crossing than those in the evening

4. Pedestrian Group Size

Reference Category: Small Group

- Alone: (B = -0.752, $p < 0.001$, $\text{Exp}(B) = 0.471$)

The alone commuters are significantly 0.471 times (52.9%) less likely to comply to the crossing than those in small groups.

- Large Group: (B = 1.205, $p < 0.001$, $\text{Exp}(B) = 3.336$)

Large groups are significantly 3.336 times more likely to comply due to the sense of safety or/and due to the peer pressure.

5. Traffic Volume

Reference Category: High Traffic Volume

- Low Traffic Volume: (B = -0.843, $p = 0.001$, $\text{Exp}(B) = 0.431$)

Pedestrians in low traffic volume areas are 0.431 times less likely to comply to the crossing as they might feel quite safer to cross.

6. Waiting Time

Reference Category: Up to 30 Seconds

- 30 to 60 Seconds: (B = -0.054, $p = 0.766$, $\text{Exp}(B) = 0.947$)

No significant effect ($p > 0.05$).but a slight decrease of 5.3% in likelihood

- 60 to 90 Seconds: (B = -1.085, $p < 0.001$, $\text{Exp}(B) = 0.338$)

Pedestrians who had to wait for 60 to 90 seconds are 66.2% less likely to comply to the crossing. ($p < 0.001$).

- 90 to 120 Seconds: (B = -1.798, $p < 0.001$, $\text{Exp}(B) = 0.166$)

Pedestrians waiting 90–120 seconds are the least likely to comply to the crossings The compliance greatly reduces by 83.4% when the pedestrians had to wait for 90 to 120 seconds

7. Constant (Intercept)

(B = 1.785, $p < 0.001$, $\text{Exp}(B) = 5.959$)

Represents the baseline odds of the behavior occurring when all predictors are at their reference category.

4.3.2.2 Model Validation

For the model validation, the goodness of fit tests was done, classification tables were analyzed and R^2 values were checked as mentioned in 3.8 Model Validation.

The tables of the model validation are presented in Appendix C.

4.3.3 Combined Compliance Model

Since, both the sites showed similar results in terms of the independent variables without much difference, the data from both the sites were combined and a final binary logistic regression model was developed for the assessment of the compliance pedestrians hold with the crossing.

4.3.3.1 Descriptive Statistics

This section provides an overview of key demographic and behavioral variables, such as age groups, gender, pedestrian group size, waiting time, time of the day and traffic conditions, in relation to compliance and non-compliance. By visually representing the distribution of these variables using bar graphs, we can identify the preliminary patterns. Out of all the total sampled pedestrians, 79.38% were found to be complying to the crossing whereas 20.61% were found to be non-compliant.

The descriptive statistics of different variables are further shown below:

a. By Gender

Table 4.36 shows how the compliance to crossing varies with the gender.

Table 4.36 Compliance * Gender Cross tabulation

Compliance * Gender Cross tabulation				
Count				
		Gender		Total
		Female	Male	
Compliance	Non compliance	233	266	499
	Compliance	1064	857	1921
Total		1297	1123	2420

b. By Age groups:

Table 4.37 shows how the compliance to crossing varies with the age groups.

Table 4.37 Compliance * Age Cross tabulation

Compliance * Age Cross tabulation						
Count						
		Age				Total
		Young aged adults	Children/ Adolescents	Middle aged adults	Elderly	
Compliance	Non compliance	273	38	136	52	499
	Compliance	959	307	567	88	1921
Total		1232	345	703	140	2420

c. By time of the day

Table 4.38 shows how the compliance to crossing varies with the time of the day

Table 4.38 Compliance * Time of the day Cross tabulation

Compliance * Time of the day Cross tabulation				
Count				
		Time of the day		Total
		Morning	Evening	
Compliance	Non compliance	221	278	499
	Compliance	948	973	1921
Total		1169	1251	2420

d. By Pedestrian group size

Table 4.39 shows how the compliance to crossing varies with the pedestrian group size.

Table 4.39 Compliance * Pedestrian group size Cross tabulation

Compliance * Pedestrian group size Cross tabulation					
Count					
		Pedestrian group size			Total
		Small group	Alone	Large group	
Compliance	Non compliance	226	214	59	499
	Compliance	834	352	735	1921
Total		1060	566	794	2420

e. By traffic volume:

Table 4.40 shows how the compliance to crossing varies with the traffic volume.

Table 4.40 Compliance * Traffic volume Cross tabulation

Compliance * Traffic volume Cross tabulation				
Count				
		Traffic volume		Total
		High traffic volume	Low traffic volume	
Compliance	Non compliance	443	56	499
	Compliance	1800	121	1921
Total		2243	177	2420

f. By waiting time:

Table 4.41 shows how the compliance to crossing varies with the waiting time.

Table 4.41 Compliance * Waiting time Cross tabulation

Compliance * Waiting time Cross tabulation						
Count						
		Waiting time				Total
		Up to 30 seconds	30 to 60 seconds	60 to 90 seconds	90 to 120 seconds	
Compliance	Non compliance	261	115	95	28	499
	Compliance	1106	584	198	33	1921
Total		1367	699	293	61	2420

The conclusions that can be drawn on the basis of descriptive statistics are presented below:

Variables	Key Observations	Insights
Gender	Male: 857 Compliance - Female: 1064 Compliance	Higher compliant behavior by females.
Age	- Highest compliance: Young aged adults(959) - Lowest: Elderly (88)	Younger groups complied to the crossings more..
Pedestrian group size	Highest compliance: - Small group(834) Lowest- Alone (352)	Individuals crossing in group are more likely to comply.
Traffic volume	High Traffic: 1800 Compliance, - Low Traffic:121 Compliance,	Compliance is overwhelmingly linked to high-traffic areas.
Time of the day	Morning: 948 Compliance, - Evening: 973 Compliance	Higher compliance in evenings..

Waiting Time	Highest Compliance- Up to 30 seconds (1106), lowest- 90 to 120 seconds (33)	The compliance greatly reduced when the pedestrians had to wait for more time.
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4.3.3.2 Logistic Regression Model

The data obtained showed the frequency of variables as shown in Table 4.42 on the basis of which the reference categories were further

Table 4.42 Frequency of variables for compliance

Variables		Frequency	Percentage
Waiting time	Up to 30 seconds	1367	56.49%
	30 to 60 seconds	699	28.88%
	60 to 90 seconds	293	12.11%
	90 to 120 seconds	61	2.52%
Age	Young aged adults	1232	50.91%
	Children/Adolescents	345	14.26%
	Middle aged adults	703	29.05%
	Elderly	140	5.79%
Pedestrian group size	Small group	1060	43.80%
	Alone	566	23.39%
	Large group	794	32.81%
Time of the day	Morning	1169	48.31%
	Evening	1251	51.69%
Traffic volume	High traffic volume	2243	92.69%
	Low traffic volume	177	7.31%
Gender	Female	1297	53.60%
	Male	1123	46.40%

Reference Categories:

The Table 4.43 Table 4.8 briefs about the reference categories for the utilization model and why they were chosen.

Table 4.43 Reference categories for compliance model

Variable	Categories	Reference Category	Reason
Age	Children/Adolescent, Young aged adults, Middle aged adults, Elderly	Young aged adults	It is the largest category (1232, 50.91%) and serves as a standard comparison.
Pedestrian Group Size	Alone, Small group, Large group	Small group	Most common category (1060, 43.80%), useful as a baseline.
Traffic Volume	High, Low	High	Majority category (92.69%), easier to interpret results.
Time of the Day	Morning, Evening	Evening	Larger group (1251, 51.69%).
Gender	Male, Female	Female	Largest category (1297, 53.6%)
Waiting Time	Up to 30 seconds, 30 to 60 seconds, 60 to 90 seconds, 90 to 120 seconds	Up to 30 seconds	Highest share (1367, 56.49%)

The compliance model was formulated using binary logistic regression method as shown in Table 4.26

Table 4.26 Binary Logistic Regression Model for Compliance

Variables in the Equation				
	B	S.E.	Sig.	Exp(B)
Female				

Male	-0.261	0.109	0.017	0.770
Age			<0.001	
Young aged adults				
Children/Adolescents	0.651	0.199	0.001	1.917
Middle aged adults	0.149	0.125	0.235	1.160
Elderly	-0.648	0.203	0.001	0.523
Morning				
Evening	-0.370	0.110	0.001	0.691
Pedestrian group size			<0.001	
Small group				
Alone	-0.803	0.120	<0.001	0.448
Large group	1.329	0.162	<0.001	3.776
High traffic volume				
Low traffic volume	-0.658	0.184	0.000	0.518
Waiting time			<0.001	
Up to 30 seconds				
30 to 60 seconds	-0.069	0.131	0.599	0.933
60 to 90 seconds	-1.012	0.158	<0.001	0.363
90 to 120 seconds	-1.893	0.307	<0.001	0.151
Constant	1.817	0.134	<0.001	6.153

The logistic regression model for the compliance model is presented in equation (4.3)

$$\log\left(\frac{P(Y_i=1)}{P(Y_i=0)}\right) = 1.817 - 0.261(\text{Male}) + 0.651(\text{Children/Adolescent}) + 0.149(\text{Middle-aged adults}) - 0.648(\text{Elderly}) - 0.370(\text{Evening}) - 0.803(\text{Alone}) + 1.329(\text{Large group}) - 0.658(\text{Low traffic volume}) - 0.069(\text{30 to 60 seconds}) - 1.012(\text{60 to 90 seconds}) - 1.893(\text{90 to 120 seconds}). \quad (4.7)$$

Interpretation of the coefficients:

1. Gender

Reference Category: Female

- Male: (B = -0.261, p = 0.017, Exp(B) = 0.770)

Males are significantly less likely to comply to crossing compared to females (23% less likely, p < 0.05).

2. Age Groups

Reference Category: Young-aged Adults

- Children/Adolescents: (B = 0.651, p = 0.001, Exp(B) = 1.917)

Children/adolescents are significantly 91.7% more likely to comply compared to young adults (p < 0.01).

- Middle-aged Adults: (B = 0.149, p = 0.235, Exp(B) = 1.160)

No significant difference in compliance compared to young adults (p > 0.05).

- Elderly: (B = -0.648, p = 0.001, Exp(B) = 0.523)

Elderly pedestrians are significantly 47.7% less likely to comply compared to young adults (p < 0.01).

3. Time of Day

Reference Category: Morning

- Evening: (B = -0.370, p = 0.001, Exp(B) = 0.691)

Pedestrians in the evening are 30.9% less likely to comply to the crossing compared to those who commute in the morning (p < 0.01).

4. Pedestrian Group Size

Reference Category: Small Group

- Alone: (B = -0.803, $p < 0.001$, $\text{Exp}(B) = 0.448$)

Pedestrians crossing alone are significantly less likely to comply compared to those in small groups (55.2% less likely, $p < 0.001$).

- Large Group: (B = 1.329, $p < 0.001$, $\text{Exp}(B) = 3.776$)
- Pedestrians in large groups are 3.776 times more likely to comply compared to small groups due to the sense of safety or/and due to the peer pressure. ($p < 0.001$).

5. Traffic Volume

Reference Category: High Traffic Volume

- Low Traffic Volume: (B = -0.658, $p < 0.001$, $\text{Exp}(B) = 0.518$)

Pedestrians in low-traffic areas are less likely to comply compared to when the traffic flow is high (48.2% less likely, $p < 0.001$).

6. Waiting Time

Reference Category: Up to 30 Seconds

- 30 to 60 Seconds: (B = -0.069, $p = 0.599$, $\text{Exp}(B) = 0.933$)

No significant effect on compliance ($p > 0.05$). but a slight decrease of 6.7%

- 60 to 90 Seconds: (B = -1.012, $p < 0.001$, $\text{Exp}(B) = 0.363$)

Pedestrians waiting 60–90 seconds are 63.7% less likely, less likely to comply ($p < 0.001$).

- 90 to 120 Seconds: (B = -1.893, $p < 0.001$, $\text{Exp}(B) = 0.151$)

The compliance significantly dropped by 84.9% when the pedestrians had to wait for 90–120 seconds ($p < 0.001$).

7. Constant (Intercept)

(B = 1.817, $p < 0.001$, $\text{Exp}(B) = 6.153$)

This represents the baseline odds of compliance when all predictors are at their reference category.

Model Validation:

For the model validation, the goodness of fit tests was done, classification tables were analyzed and R^2 values were checked as mentioned in 3.8 Model Validation.

1. Omnibus Tests of Model Coefficients:

The hypotheses for the test are as discussed in Model Validation (1)

A low p-value (< 0.05) indicates that at least one predictor is significant as we reject the null hypothesis, so the model is useful.

Table 4.45 Omnibus Tests of Model Coefficients for Compliance model

		Chi-square (χ^2)	df	Sig.
Step 1	Step	318.706	11	<0.001
	Block	318.706	11	<0.001
	Model	318.706	11	<0.001

2. Hosmer and Lemeshow Test

Since the p-value is greater than 0.05, as shown in Table 4.46 we fail to reject the null hypothesis, which is mentioned in Model Validation (2) suggesting that the logistic regression model provides a good fit to the data. This suggests that the predicted probabilities from the model align well with the actual outcomes, confirming the model's reliability in explaining the dependent variable.

Table 4.46 Hosmer and Lemeshow Test for Compliance model

Step	Chi-square (χ^2)	df	Sig.
1	10.968	8	0.203

3. Classification Table

The classification table shown in Table 4.47 provides an evaluation of the logistic regression for compliance model's predictive performance

Table 4.47 Classification Table for Compliance model

Classification Table ^a				
Observed		Predicted		
		Compliance		Percentage
		No compliance	Compliance	Correct
Compliance	No Compliance	120	379	31.7
	Compliance	46	1875	97.6
Overall Percentage				82.4

The classification table compares the observed outcomes (actual compliance vs. non-compliance) with the predicted outcomes. The model correctly classifies 31.7% of the non-compliance cases (120 out of 499) and 97.6% of the compliance cases (1875 out of 1921). The overall classification accuracy is 82.4%, indicating that the model performs moderately well in distinguishing between compliance and non-compliance.

The R^2 values are presented in the Table4.48

Table4.48 Model Summary of Compliance model

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	2144.254	0.123	0.193

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study assessed the utilization, compliance and awareness of Pelican crossings by analyzing pedestrian behavior at two selected sites in Gwarko-Lamatar road. The findings revealed several key insights into how different demographic factors influence pedestrian interactions with these crossings.

1. Awareness

- Overall awareness of Pelican crossings was low across all age groups, with children/adolescents showing the highest awareness and elderly pedestrians exhibiting the lowest.
- Males had slightly higher awareness of the crossings than the females.
- Pedestrians with lower educational levels had a greater awareness of Pelican crossings than those with higher education, possibly due to the educational programs they attended at schools.

2. Utilization

- Female pedestrians were more likely to utilize the pushbuttons as compared to males probably due to their risk-averse personality.
- Younger pedestrians had the highest utilization rates, while elderly pedestrians showed the lowest likelihood of using the pushbuttons since the younger ones had higher awareness on how to use the pushbuttons.
- Individuals crossing alone were more likely to press the pushbutton than those crossing in groups.
- Higher traffic volume positively influenced pushbutton utilization, whereas lower traffic volume resulted in decreased usage.

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3. Compliance

- Compliance with pedestrian signals decreased considerably as waiting time increased, with a significant drop in adherence for waiting times exceeding 60 seconds. Those pedestrians who had to wait for 90 to 120 seconds were highly non-compliant with the compliance drop up to 84.9%.
- Pedestrians in larger group demonstrated higher compliance compared to those crossing alone.
- Children/adolescents) had the highest likelihood of the compliance; 91.7% more likely to comply compared to young adults, since they had higher awareness, while elderly pedestrians showed the lowest probably due to their lack of knowledge on the crossings.
- Compliance rates were higher in the morning than in the evening.
- Lower traffic volumes resulted in decreased compliance, suggesting that pedestrians take more risks when traffic is sparse.

5.2 Recommendations

1. Public Awareness Campaigns

- Initiate targeted awareness programs, particularly for young adults and elderly pedestrians, to educate them on the correct usage of Pelican crossings as we found that those individuals who attended educational programs were using the pushbuttons as well as were highly compliant.
- Introduce community outreach programs to familiarize pedestrians with pedestrian signalized crossings.

2. Infrastructure and Design Improvements

- Reduce pedestrian waiting times by optimizing traffic signal timing to encourage compliance.
- Improve visibility and signage to make Pelican crossings more noticeable, especially in high-risk areas as a lot of pedestrians talked about the informative sign boards not being placed in a proper space.

3. Enforcement and Policy Measures

- Implement stricter enforcement to ensure that pedestrians adhere to signalized crossings.

- Introduce certain penalties for those who fail to comply to the signals at pedestrian crossings.
 - Conduct routine monitoring and evaluations to assess the effectiveness of Pelican crossings and make necessary adjustments.
4. Behavioral Interventions
- Encourage lone pedestrians to use pushbuttons through strategically placed signage and informative messages.

The recommended future researches are:

- Vehicular delay during “ghost” pedestrian intervals when pedestrian activates the pushbutton but jaywalks.
- The effect on vehicular flow/vehicle queuing.
- Study of scenario for the differently abled groups.
- Study of other different sites that could not be included in this study.

REFERENCES

- Boniphace Kutela, H. T. (2020). Evaluating the influential factors for pushbutton utilization at signalized. *Safety Science*.
- Darcin Akin, V. P. (2007). Pedestrian crossing compliance characteristics at-grade signalized crosswalks: case study in a Downtown-university Campus environment. *86th Annual Meeting of Transportation Research*.
- Eren Dağlı, A. G. (2024, March). Investigation of Pedestrian and Driver Behaviors at Push-Button Crosswalk on Main Arterials of Urban Road: A case study of Samsun City, Turkiye. *International Journal of Engineering & Applied Sciences (IJEAS)*, 16(1), 44-62.
- Huang, H. F. (2001). *An Evaluation of Illuminated Pedestrian Push Buttons in Windsor, Ontario*. Report number FHWA-RD-00-102, Federal Highway Administration.
- Nam Seok Kim, S. S. (2017). Performance comparison between pedestrian push-button and pre-timed pedestrian crossings at midblock: a Korean case study. *Transportation Planning and Technology*, 40(6), 706-721.
- Nursitihazlin Ahmad Termida, M. M. (2019). Behavioural observations of adult-child pairs at a Pelican crossing: A case study in Kuala Lumpur. *International Journal of Integrated Engineering*, 3(1), 1-4.
- Pritam Shah, P. B. (2023). Effectiveness of Traffic Signal Countdown Timers on Pedestrian Crossings Behaviour: A case study at Tripureshwor and Narayangopal Intersections. *Proceedings of 13th IOE Graduate Conference*, (p. Volume: 13).
- Putri, B. Y. (2021). The Performance of Demand Responsive Pelican Crossing at Midblock Pedestrian Crossing Facility. *IOP Conference Series: Earth and Environmental Science*.

- Rajendra Karkee, A. H. (2016, April). Epidemiology of road traffic injuries in Nepal, 2001–2013: systematic review and secondary data analysis. *BMJ*, 6(4).
- Rajja Shilpakar, P. B. (2022). An Assesment of Pedestrian Compliance on using Foot over Bridge: A case study of Kathmandu Valley. *Proceedings of 12th IOE Graduate Conference*, (p. Volume: 12).
- Richard Atta Boateng, V. K.-S. (2018). A comparison of safety benefits of pedestrian countdown signals with and without pushbuttons in Michigan. *Traffic Injury Prevention*.
- Ron Van Houten, R. E.-L. (2006). Pedestrian Push-Button Confirmation Increases Call Button Usage and Compliance. *Transportation Research Record: Journal of the Transportation Research Board*.
- Sabyasachi Biswas, I. G. (2017, January). Effect of Traffic Signal Countdown Timers on Pedestrian Crossings at Signalized Intersection. *Transportation in Developing Economies*, 3.
- Sia Mwendu, B. K. (2020, August). Signalized Midblock Crosswalks Experience In Dar Es Salaam, Tanzania: An Evaluation Of Awareness And Utilization. *Journal of Multidisciplinary Engineering Science Studies (JMESS)*, Vol. 6 Issue 8.
- WHO, W. H. (2023). *Road Traffic Injuries*.
- Xiaofeng Li, Y.-J. W. (2021). *Real-time estimation of pedestrian volume at button-activated midblock crosswalks using traffic controller event-based data*. Transportation Research Part C.

Internet

- <https://whatthenepal.com/2023/11/27/innovative-pelican-crossing-traffic-lights-launched-in-kathmandu-babarmahal->
- [KMC installs Pelican crossings at 36 locations - myRepublica - The New York Times Partner.](#)
- [Latest news of Nepal in English, Latest News Articles | Republica](#)

APPENDIX A: SAMPLE QUESTIONNAIRE

1. Age

- <20 years
- 20-39 years
- 40-59 years
- 60+ years

2. Gender

- Male
- Female
- Non-binary/Prefer not to say

3. Study Level

- Below High School
- High School
- Undergraduate
- Graduate/Postgraduate

4. How often do you use the crossing?

- Daily
- Several times a week
- Occasionally
- Rarely

5. Have you ever used a pelican crossing before?

- Yes
- No

6. How familiar are you with pelican crossings?

- Very familiar
- Not very familiar
- Never seen/heard of this before

7. What do you understand of the "pelican crossing"?

- A type of pedestrian crossing
- A crossing with traffic lights controlled by pedestrian
- A crossing for cyclists
- I'm not sure

8. Have you ever seen or participated in any campaigns that aim to educate the public about pelican crossings?

- Yes
- No

9. What action should a pedestrian take at a pelican crossing before crossing the road?

- Wait for the green pedestrian signal
- Wait for the traffic lights to turn red
- Just cross when it feels safe
- Press the pedestrian signal button and wait for the green light

**APPENDIX B: DESCRIPTIVE STATISTICS OF
INDIVIDUAL SITES**

A. Descriptive Statistics of Utilization of Pushbuttons at Site I:Krishna Mandir

a. By Gender

Utilization * Gender Cross tabulation				
Count				
		Gender		
		Male	Female	Total
Utilization	Non utilization	87	69	156
	Utilization	118	124	242
Total		205	193	398

b. By Age groups:

Utilization * Age Crosstabulation						
Count						
		Age				Total
		Young aged adults	Children/ Adolescents	Middle aged adults	Elderly	
Utilization	Non utilization	78	6	51	21	156
	Utilization	139	19	72	12	242
Total		217	25	123	33	398

c. By pedestrian group size:

Utilization * Pedestrian group size Crosstabulation					
Count					
		Pedestrian group size			Total
		Alone	Small group	Large group	
Utilization	Non utilization	75	71	10	156
	Utilization	135	97	10	242
Total		210	168	20	398

d. By traffic volume:

Utilization * Traffic volume Crosstabulation				
Count				
		Traffic volume		Total
		High	Low	
Utilization	Non utilization	119	37	156
	Utilization	227	15	242
Total		346	52	398

e. By time of the day

Utilization * Time of the day Crosstabulation				
Count				
		Time of the day		Total
		Morning	Evening	
Utilization	Non utilization	87	69	156
	Utilization	136	106	242
Total		223	175	398

B. Descriptive Statistics of Utilization of Pushbuttons at Site II:United School

a. By Gender:

Utilization * Gender Crosstabulation				
Count				
		Gender		Total
		Male	Female	
Utilization	No utilization	130	76	206
	Utilization	147	138	285
Total		277	214	491

b. By Age groups

Utilization * Age Cross tabulation						
Count						
		Age				Total
		Children/ Adolescent	Young aged adults	Middle aged adults	Elderly	
Utilization	No utilization	54	75	63	14	206
	Utilization	110	85	84	6	285
Total		164	160	147	20	491

c. By pedestrian group size

Utilization * Pedestrian group size Crosstabulation					
Count					
		Pedestrian group size			Total
		Alone	Small group	Large group	
Utilization	No utilization	85	93	28	206
	Utilization	164	93	28	285
Total		249	186	56	491

d. By traffic volume

Utilization * Traffic volume Crosstabulation				
Count				
		Traffic volume		Total
		High	Low	
Utilization	No utilization	168	38	206
	Utilization	256	29	285
Total		424	67	491

e. By time of the day

Utilization * Time of the day Crosstabulation				
Count				
		Time of the day		Total
		Morning	Evening	
Utilization	No utilization	104	102	206
	Utilization	153	132	285
Total		257	234	491

C. Descriptive Statistics of Compliance at Site I: Krishna Mandir

a. By Gender

Compliance * Gender Crosstabulation				
Count				
		Gender		Total
		Female	Male	
Compliance	0	110	124	234
	1	514	419	933
Total		624	543	1167

b. By Age groups

Compliance * Age Crosstabulation						
Count						
		Age				Total
		Young aged adults	Children/ Adolescents	Middle aged adults	Elderly	
Compliance	0	130	11	68	25	234
	1	486	115	288	44	933
Total		616	126	356	69	1167

c. By pedestrian group size

Compliance * Pedestrian group size Crosstabulation					
Count					
		Pedestrian group size			Total
		Small group	Alone	Large group	
Compliance	0	106	103	25	234
	1	404	166	363	933
Total		510	269	388	1167

d. By traffic volume

Compliance * Traffic volume Crosstabulation				
Count				
		Traffic volume		Total
		High	Low	
Compliance	0	208	26	234
	1	868	65	933
Total		1076	91	1167

e. By waiting time

Compliance * Waiting time Crosstabulation						
Count						
		Waiting time				Total
		Upto 30 seconds	30 to 60 seconds	60 to 90 seconds	90 to 120 seconds	
Compliance	0	122	55	44	13	234
	1	535	285	99	14	933
Total		657	340	143	27	1167

f. By time of the day

Compliance * Time of the day Crosstabulation				
Count				
		Time of the day		Total
		Evening	Morning	
Compliance	0	158	76	234
	1	567	366	933
Total		725	442	1167

D. Descriptive Statistics of Compliance at Site II:United School

a. By Gender

Compliance * Gender Crosstabulation					
Count					
		Gender			Total
		Female	Male		
Compliance	Non compliance	121	140	261	
	Compliance	552	440	992	
Total		673	580	1253	

b. By Age groups

Compliance * Age Crosstabulation						
Count						
		Age				Total
		Young aged adults	Children/ Adolescents	Middle aged adults	Elderly	
Compliance	Non compliance	139	27	68	27	261
	Compliance	477	192	279	44	992
Total		616	219	347	71	1253

c. By Pedestrian group size

Compliance * Pedestrian group size Crosstabulation					
Count					
		Pedestrian group size			Total
		Small group	Alone	Large group	
Compliance	Non compliance	118	110	33	261
	Compliance	432	187	373	992
Total		550	297	406	1253

d. By traffic volume

Compliance * Traffic volume Crosstabulation				
Count				
		Traffic volume		Total
		High	Low	
Compliance	Non compliance	231	30	261
	Compliance	936	56	992
Total		1167	86	1253

e. By waiting time

Compliance * Waiting time Crosstabulation						
Count						
		Waiting time				Total
		Upto 30 seconds	30 to 60 seconds	60 to 90 seconds	90 to 120 seconds	
Compliance	Non compliance	136	59	51	15	261
	Compliance	574	300	99	19	992
Total		710	359	150	34	1253

f. By time of the day

Compliance * Time of the day Crosstabulation				
Count				
		Time of the day		Total
		Morning	Evening	
Compliance	Non compliance	141	120	261
	Compliance	586	406	992
Total		727	526	1253

**APPENDIX C: MODEL VALIDATION
OF INDIVIDUAL SITES**

A. Utilization Model Validation for Site I: Krishna Mandir:

These tests are done considering the null and alternate hypotheses as discussed in 3.8 Model Validation section.

1. Omnibus Tests of Model Coefficients

Omnibus Tests of Model Coefficients				
		Chi-square (χ^2)	df	Significance.
Step 1	Step	47.382	7	<0.001
	Block	47.382	7	<0.001
	Model	47.382	7	<0.001

A low p-value (< 0.05) indicates that at least one predictor is significant as we reject the null hypothesis, so the model is useful.

2. Hosmer and Lemeshow Test:

Hosmer and Lemeshow Test			
Step 1	Chi-square (χ^2)	df	Significance.
	4.010	8	0.856

Since the p-value is greater than 0.05, we fail to reject the null hypothesis, suggesting that the logistic regression model provides a good fit to the data.

3. Classification Table:

Classification Table				
Observed		Predicted		
		Utilization		Percentage Correct
		Non utilization	Utilization	
Utilization	Non utilization	59	97	37.8
	Utilization	30	212	87.6
Overall Percentage				68.1

The classification table compares the observed outcomes (actual utilization vs. non-utilization) with the predicted outcomes. The model correctly classifies 37.8% of the non-utilization cases (59 out of 156) and 87.6% of the utilization cases (212 out of 242). The overall classification accuracy is 68.1%, indicating that the model performs moderately well in distinguishing between utilization and non-utilization.

4. Model Summary:

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	485.236	0.113	0.153

The R^2 values were found to be 0.113 and 0.153.

B. Utilization Model Validation for Site II: United School

These tests are done considering the null and alternate hypotheses as discussed in 3.8 Model Validation section.

1. Omnibus Tests of Model Coefficients

Omnibus Tests of Model Coefficients				
		Chi-square (χ^2)	df	Significance.
Step 1	Step	34.342	7	<0.001
	Block	34.342	7	<0.001
	Model	34.342	7	<0.001

A low p-value (< 0.05) indicates that at least one predictor is significant as we reject the null hypothesis, so the model is useful.

2. Hosmer and Lemeshow Test:

Step	Chi-square (χ^2)	df	Sig.
1	11.209	8	0.19

Since the p-value is greater than 0.05, we fail to reject the null hypothesis, suggesting that the logistic regression model provides a good fit to the data.

3. Classification Table

Classification Table ^a				
Observed		Predicted		
		Utilization		Percentage Correct
		No utilization	Utilization	
Utilization	No utilization	79	127	38.3
	Utilization	60	225	78.9
Overall Percentage				61.9

The classification table shown compares the observed outcomes (actual utilization vs. non-utilization) with the predicted outcomes. The model correctly classifies 38.3% of the non-utilization cases (79 out of 206) and 78.9% of the utilization cases (225 out of 285). The overall classification accuracy is 61.9%, indicating that the model performs moderately well in distinguishing between utilization and non-utilization.

4. Model Summary

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	633.563 ^a	0.068	0.091

The R² values were found to be 0.068 and 0.091.

C. Compliance Model Validation for Site I: Krishna Mandir

These tests are done considering the null and alternate hypotheses as discussed in 3.8 Model Validation section.

1. Omnibus Tests of Model Coefficients:

		Chi-square (χ^2)	df	Sig.
Step 1	Step	166.931	11	<0.001
	Block	166.931	11	<0.001
	Model	166.931	11	<0.001

A low p-value (< 0.05) indicates that at least one predictor is significant as we reject the null hypothesis, so the model is useful

2. Hosmer and Lemeshow Test

Step	Chi-square (χ^2)	df	Sig.
1	3.907	8	0.865

Since the p-value is greater than 0.05, we fail to reject the null hypothesis, suggesting that the logistic regression model provides a good fit to the data

3. Classification Table:

Classification Table ^a				
Observed		Predicted		
		Compliance		Percentage Correct
		No compliance	Compliance	
Compliance	No Compliance	69	165	29.5
	Compliance	21	912	97.7
Overall Percentage				84.1

The classification table compares the observed outcomes (actual compliance vs. non-compliance) with the predicted outcomes. The model correctly classifies 29.5% of the non-compliance cases (69 out of 234) and 97.7% of the compliance cases (912 out of 933). The overall classification accuracy is 84.1%, indicating that the model

performs moderately well in distinguishing between compliance and non-compliance.

4. Model Summary

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	633.563	0.113	0.212

The R^2 values were found to be 0.113 and 0.212.

D. Compliance Model Validation for Site II: United School

These tests are done considering the null and alternate hypotheses as discussed in 3.8 Model Validation section.

1. Omnibus Tests of Model Coefficients

		Chi-square (χ^2)	df	Sig.
Step 1	Step	161.228	11	<0.001
	Block	161.228	11	<0.001
	Model	161.228	11	<0.001

A low p-value (< 0.05) indicates that at least one predictor is significant as we reject the null hypothesis, so the model is useful

2. Hosmer and Lemeshow Test

Step	Chi-square (χ^2)	df	Sig.
1	8.448	8	0.387

Since the p-value is greater than 0.05, we fail to reject the null hypothesis, suggesting that the logistic regression model provides a good fit to the data

3. Classification Table:

Classification Table				
Observed		Predicted		
		Compliance		Percentage
		No compliance	Compliance	Correct
Compliance	No Compliance	73	188	27.9
	Compliance	26	966	97.4
Overall Percentage				82.9

The classification table compares the observed outcomes (actual compliance vs. non-compliance) with the predicted outcomes. The model correctly classifies 27.9% of the non-compliance cases (73 out of 261) and 97.4% of the compliance cases (966 out of 992). The overall classification accuracy is 82.9%, indicating that the model performs moderately well in distinguishing between compliance and non-compliance.

4. Model Summary

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1002.670	0.121	0.188

The R^2 values were found to be 0.121 and 0.188.