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**Bicyclist's Perception based Level of Service in Heterogeneous Traffic Condition: A
Case Study of Bharatpur, Nepal.**

by

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**A THESIS SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF SCIENCE IN TRANSPORTATION ENGINEERING**

**DEPARTMENT OF CIVIL ENGINEERING
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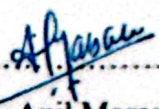
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The undersigned certify that they have read and recommended to Institute of Engineering for acceptance, a thesis entitled **“Bicyclist’s Perception based Level of Service in Heterogeneous Traffic Condition: A Case Study of Bharatpur, Nepal.”** submitted by Rabin Dhital in partial fulfillment of the requirement for degree of Master of Science in Transportation Engineering.


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ABSTRACT

In Bharatpur bicyclists share roadway with complex traffic makes vulnerable to safety risks. To address this issue, it is crucial to assess bicyclists' perception regarding safety or comfort and intervention for improvement. This study aimed to assess a road section for bicycling suitability by considering Average Traffic Volume (ATV), Average Traffic Speed, On-Street Parking (ONP), Settlement Type (ST), Heavy Vehicle Percentage (HVP) and Pavement Type (PT) of roadway segment. Bicyclist's perceptions of roadway suitability for bicycling were collected using a Five-point Likert scale across selected roadway segments in Bharatpur, a mid-sized city of Nepal. Using this data, bicyclist perception-based Level of service (PLOS) criteria were established through Ordered-Probit (OP) model, which are well-suited for analyzing the dependent variable (Bicyclist perception-based Level of service (PLOS)) ordinal in nature. The study revealed that among the continuous independent variables, the Average Traffic Speed, Average Traffic Volume, On-street parking Proportion (ONP) had the most significant impact on perceived LOS, followed by Shoulder width. In case of categorical independent variables Pavement type, settlement type and continuous variable Heavy Vehicle Percentage are non-significant to Bicyclist perceived based Level of service (PLOS). This OP model can predict LOSB and LOSC correctly are 60.71% and 75% respectively. These bicyclist perception-based Level of service (PLOS) used to assess the suitability of selected road section for bicycling in Bharatpur. This study found that most (10 out of 12) of the roadway section offered Perceived LOSC (moderately good) implies need of bicycle infrastructure. The segments categorized under LOS D i.e. segments 10 and 12 are given the highest priority which based on value of latent score (z).

Keywords: Bicycle; Roadway Section; Bicyclist perception-based Level of service (PLOS); Ordered-probit (OP) model.

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LIST OF ABBREVIATION

BCI	Bicycle Compatibility Index
BLOS	Bicycle Level of Service
BSL	Bicycle Stress Level
BSS	Bicycle Suitability Score
km	kilometer
m	meter
UN	United Nations
BMC	Bharatpur Metropolitan City
ONP	On street Parking Proportion
OLS	Ordinary Least Square Method
HCM	Highway Capacity Manual
HCV	Heavy Commercial Vehicle
LCV	Light Commercial Vehicle
PT	Pavement Type
ST	Settlement Type
HVP	Heavy Vehicle Percentage
OP	Ordered Probit

CHAPTER 1: INTRODUCTION

1.1 Background

Bicycles serve not only as a means of transportation but are also widely used for recreational and leisure activities. They are often regarded as the most popular mode of transport globally. According to Sibilski (2015), more than 2 billion bicycles are currently in use worldwide, and this number is expected to rise to 5 billion by 2050. He also notes that over half of the global population knows how to ride a bicycle. The Netherlands leads in bicycle usage, with 99% of its citizens being cyclists (Kenny, 2015). Remarkably, the city of Amsterdam alone features over 500 kilometers of dedicated bicycle lanes (Gaada.com, 2015).

Private transportation is often considered a more convenient option for individual mobility. However, the growing demand for private vehicles continues to rise despite the already strained capacity of road networks. To promote cycling, various bicycle-friendly facilities and dedicated lanes have been introduced. These efforts aim to ease traffic congestion, which remains a significant challenge in many urban areas of Nepal.

The bicycle is recognized for its environmental and health benefits; governments worldwide are striving to develop bicycle-friendly road infrastructure (Beura et al. 2017). In underdeveloped developing countries like Nepal, where around 30% of households owned a bicycle according to the Census 2021, road facilities are not primarily designed to ensure bicyclists' perceived safety and satisfaction. According to national census 2011, 35.2% of the total household of Nepal own a bicycle which reduced to 30% at 2021 AD. From the same census household own motorcycle 9.58% in 2068 abruptly increased to 27%. Potential bicyclists are increasingly choosing alternative modes of transport due to inadequate infrastructure and unsafe cycling conditions (Shrestha et. al, 2022). Cities which were renowned for cycle cities like Bharatpur in Nepal have experienced a significant decline in bicycle usage (Khanal, 2021). Although other factors may also play a role, the lack of safe infrastructure contributes majorly for bicycling in Nepal. Therefore, it is essential to assess the quality of bicycle travel to pinpoint areas needing improvements in

infrastructure. This study also recommends measures to support cycling safety, comfort and convenience.

Bicyclist perception-based Level of service (PLOS) is a valuable tool for evaluating the current suitability of roadway segments for cycling and prioritizing those segments for infrastructure upgrades. Highway Capacity Manual (HCM)-based LOS, which emphasis on traffic convenience, bicyclist-perceived LOS places significant focuses on cyclist safety as well as functional parameters (Turner et al., 1997). Bicyclist-perceived LOS used to evaluate how well specific roadway sections accommodate bicycle travel in terms of safety, comfort, and convenience. (Jensen, 2007; Foster, 2014).

While substantial research exists in developed countries like the United States and Denmark, limited studies (Jain and Tiwari, 2012; Kang and Lee, 2012) have evaluated bicycle compatibility and developed bicycle LOS criteria in the context of developing countries. In that case, Nepali context study related to bicyclist perception LOS is Nil. Considering the distinct traffic patterns, compliance with traffic rules, and typical travel behavior of road users in under-developed countries, it is important to determine factors that impact on bicyclist-perception based LOS in typical Nepali city Bharatpurs' conditions and gauge their relative impact on bicycle suitability.

1.2 Problem statement

Bicycles are a vital mode of transport in terai belt cities, yet these cities lack adequate and safe infrastructure for bicyclists. As a result, bicyclists must share road section with heavy traffic, uplift their chances of accidents and discomfort. Evaluating the road section for bicycling from the perception of bicyclist's is crucial to identify problematic areas and propose targeted interventions. However, research on bicyclist-perception based Level of Service (LOS) is scarce in the context of under-developed countries like Nepal, where traffic dynamics and user behaviors differ significantly from developed nations. Additionally, the lack of systematic tools to assess bicycle suitability in such complex traffic environments hinders effective planning and prioritization of infrastructure upgrades.

At last decade more than 700 km of road network had been upgraded to blacktop in Bharatpur (BMC Annual Report 2022). Despite that, newly constructed roads don't seem to be more attractive to bicyclist. There are numerous reasons behind the decline of bicycle culture of Bharatpur like: availability of public vehicles, uplift on lifestyle, shift to motorbike, incompatibility on road etc. Among them major concern is safety and comfort factors of roads toward bicyclists. Before constructing the bicycle congruous roads planner, designer and leaders must investigate the current condition of service delivery of road regarding bicycling. So, this study helps to figure out overall perception of bicyclists toward road segment regarding is it safe and comfortable for riding a bicycle.

1.3 Objectives of study

The main objective of the study is to develop a bicyclist's perception-based Level of Service (PLOS) model in mixed traffic condition on Bharatpur. The specific objectives are enlisted as below:

- To develop the model based of bicyclist's perceived LOS of roadway using ordered probit model.
- To prioritize selected roadway segments for improvements or interventions.

1.4 Scope of the study

Twelve homogenous road sections from various area of Bharatpur Metropolitan City were considered for study.

- Create a comprehensive tool to assess the road section suitability for bicycling based on users' perception of safety, comfort, and convenience.
- Collect bicyclist-perceived LOS data using intercept surveys, capturing user feedback on road conditions, traffic characteristics, and infrastructure.
- Use the ordered probit (OP) model to analyze and quantify the impact of assumed attributes on bicyclist-perception based LOS.
- Use the Ordered probit model to determine the respective perceived LOS and prioritization of road section for improvement.

1.5 Study Limitation

- The study is conducted in mid-sized Nepali city Bharatpur. The findings may not be directly applicable to larger cities or rural areas with differing traffic and infrastructure characteristics.
- Data collection is limited to evening peak hours, which might not account for variations in traffic patterns and bicyclist behavior during other times of the day.
- Certain factors, such as weather conditions, cyclist demographics (e.g., age, gender), and road lighting, which could influence bicyclist-perceived LOS, are not considered.
- Video-based user surveys, commonly used in developed countries for detailed analysis, are not employed due to participants' unfamiliarity with such methods.
- The study does not account for dynamic traffic conditions or seasonal changes, which could affect LOS and bicyclists' comfort.

1.6 Organization of Report

The thesis report consists of five chapters as follows:

Chapter 1: Introduction: This chapter describes shortly about the Perceived LOS and Bicyclist.

Chapter 2: Literature Review: This chapter discusses the available literature on bicycle suitability and LOS in both developed and developing countries. Summary of methodologies used in prior studies, highlighting the gaps in the context of Nepali cities

Chapter 3: Research Methodology: This chapter consists of study area, data collection and extraction, and data analysis used in this study to accomplish the research objectives.

Chapter 4: Results and discussions: This chapter presents descriptive statistics on demographic and travel behavior, study on bicyclist perceived LOS and model interpretation of ordered probit model of perceived LOS.

Chapter 5: Conclusions and Recommendation: This chapter discusses the summary of the outcomes of the thesis.

CHAPTER 2: LITERATURE REVIEW

2.1 Bicycle LOS Models

Several researchers and practitioners have developed various techniques to assess the quality of bicycling on roadway segments. Turner et al. (1997) categorized these techniques into three main approaches: stress level-based (Sorton and Walsh, 1994; Mekuria et al., 2012; Mingu, 2015), bicycle suitability criteria-based (Landis et al., 1997; Harkey et al., 1998), and capacity-based (HCM 2000). Among these, the suitability-based approach is the most widely adopted, particularly empirical methods that link bicyclists' perceptions with roadway characteristics (Turner et al., 1997). Suitability-based measures can be further classified into index-based approaches, such as the Roadway Condition Index (RCI) by Davis (1987), modified RCI by Epperson (1994), the Bicycle Interaction Hazard Score (BIHS) by Landis (1994), and Dixon's (1996) approach, as well as empirically derived Level of Service (LOS) criteria, which have been widely accepted in studies such as those by Landis et al. (1997), Harkey et al. (1998), and Jensen (2007). Empirical criteria are generally considered more appropriate for assessing bicycle LOS, as demonstrated in research incorporating methodologies from the Highway Capacity Manual (HCM, 2010). Consequently, this study adopts an empirical approach to determine bicyclist-perceived LOS by linking perception data with roadway functional and operational characteristics. The key finding of different literature are presented in below Table 2.1.

2.2 Factors Influencing Bicyclist Perception

Several studies have identified key factors influencing bicyclist-perceived LOS, which this study also considers. Traffic-related factors include vehicle volume (Landis et al., 1997; Harkey et al., 1998; Kang & Lee, 2012) and the percentage of heavy vehicles (Landis et al., 1997; Jensen, 2007). Roadway characteristics such as shoulder width (Noël et al., 2003), pavement condition (Landis et al., 1997), and land use type (Jain & Tiwari, 2012) also significantly affect bicycle suitability. Additionally, operational factors like on-street

parking (Harkey et al., 1998; Jensen, 2007) and average traffic speed (Landis et al., 1997; Foster, 2014) play crucial roles in bicyclists' perception of road safety and comfort.

2.3 Bicycle LOS Modeling Approaches

A review of existing studies reveals that most research on quantifying bicycle travel quality has been conducted in developed countries such as the United States and Denmark, as well as developing nations like South Korea and India (Jain & Tiwari, 2012; Kang & Lee, 2012). However, there has been no study conducted in an underdeveloped country like Nepal, where infrastructure for bicyclists is lacking, traffic behaviour significantly differs from that in developed and developing countries, and authorities often overlook bicyclist safety in road design. Moreover, while ordinary least squares (OLS) regression is the most commonly used technique for modelling bicyclists' perceived LOS (Landis et al., 1997; Harkey et al., 1998), it does not account for the ordinal nature of LOS ratings. Only a few studies (Jensen, 2007; Kang & Lee, 2012; Foster, 2014) have utilized ordered models, such as cumulative logistic regression (Jensen, 2007; Foster, 2014) and ordered probit (Kang & Lee, 2012), highlighting the need for further exploration of these techniques in bicycle LOS modelling.

To address these research gaps and contribute to existing knowledge, this study focuses on identifying and quantifying key factors influencing bicycle suitability on roadway segments in underdeveloped countries like Nepal. This study makes three significant contributions. First, it develops bicycle suitability criteria that capture user perceptions, allowing for the identification of the most suitable roadway segments for bicycling. Second, unlike most previous studies that collected bicyclists' perceived suitability scores using an ordered Likert scale but applied linear regression models (Landis et al., 1997; Harkey et al., 1998), this study employs an ordered probit model to better account for the ordinal nature of LOS data. Third, it evaluates roadway segments based on bicyclist-perceived LOS criteria to assess current conditions and identify areas that require infrastructure improvements. Since it is impractical to improve all road segments simultaneously due to resource constraints, this study provides a systematic approach to prioritizing routes for bicycle infrastructure development. By integrating these aspects, this research offers a structured and scientifically grounded methodology for evaluating and improving bicycle infrastructure in underdeveloped regions

Table 2. 1:Key Finding of literature

Literature Title	Study Location	Key Finding of literature
Bicycle level of service (BLOS) — Landis et al. (1997)	Different urban sections of the United States	The study found that bicyclists’ perceptions of roadway safety and comfort—measured as Bicycle Level of Service (BLOS)—are significantly influenced by measurable roadway and traffic characteristics. Key factors affecting perceived service quality include traffic volume, speed, presence of heavy vehicles, pavement surface condition, and the width available for bicycling. Notably, the presence of striped bicycle lanes substantially improved perceived safety, even when the physical space remained the same. Poor pavement conditions negatively impacted perceptions, confirming that real-time experience is essential for accurate evaluation. Additionally, less experienced riders tended to perceive roads as safer than more experienced cyclists, indicating possible differences in hazard awareness. The resulting BLOS model achieved strong statistical reliability ($R^2 = 0.73$) and is applicable to a wide range of urban environments across the U.S.
Bicycle compatibility index (BCI) —Harkey et al. (1998)	Several cities in the United States	The study developed a Bicycle Compatibility Index (BCI) to quantify how suitable urban and suburban roadways are for shared use by bicycles and motor vehicles, focusing on cyclists’ comfort levels. Using video surveys of 67 roadway segments from multiple U.S. cities, 202 participants rated their comfort based on variables like traffic speed, volume, lane width, presence of bike lanes, and roadside development. A regression model incorporating eight key variables explained 89% of the variance in comfort ratings ($R^2 = 0.89$), showing that features like bike lanes, wider curb lanes, and residential settings improved comfort, while high speeds, heavy traffic, and on-street parking reduced it. The model was validated against field observations and led to the development of Bicycle Level of Service (LOS) categories (A to F). Additionally, separate models were analyzed for different cyclist experience levels, though the universal model was recommended for general use. This tool enables engineers

		and planners to assess and improve roadway designs, prioritize upgrades, and guide future planning to enhance bicycle-friendliness across regions.
Evaluation Method for Bicycle Lane Level of Service Based on User Perception and Capacity Simulation- Zhang et al, (2019)	Hangzhou, China	The study successfully modeled bicycle LOS based on real-world factors such as traffic density, speed, and obstacle perception. Level C LOS was identified as the most balanced design choice, ensuring efficient space utilization and user comfort. Lower LOS levels (D and E) indicated high traffic congestion, frequent disturbances, and decreased user satisfaction. Obstacle density and load degree significantly impact cyclists' perceived comfort and safety, making them crucial for bicycle lane design
Level of Service Model of the Non-Motorized Vehicle- Xiaofei Ye et.al (2022)	Chinese cities: Ningbo, Nanjing, and Guilin	It found that higher e-bike volumes, traffic conflicts, and delays significantly lowered LOS, while dedicated crossing facilities improved user experience. The cumulative logistic regression model outperformed linear regression in accurately predicting LOS ratings. The findings highlight the need for improved intersection design, signal timing adjustments, and dedicated non-motorized lanes to enhance bicyclist safety and comfort.
Unsignalized Intersection Level of Service: A Bicyclist's Perspective- Sambit Kumar et.al (2021)	five Indian cities: Lucknow, Nagpur, Ranchi, Rourkela, and Bhubaneswar.	The study developed a BLOS model for unsignalized intersections in mixed traffic, identifying bicycle delay as the most critical factor. With 89% of intersections rated 'C' or worse, the model ($R^2 = 0.83$) highlights poor bicycling conditions. Key improvements include reducing delays, limiting on-street parking, and enhancing infrastructure

CHAPTER 3: METHODOLOGY

3.1 Research design

Proposed research design methodology framework is as shown in Figure 3.1.

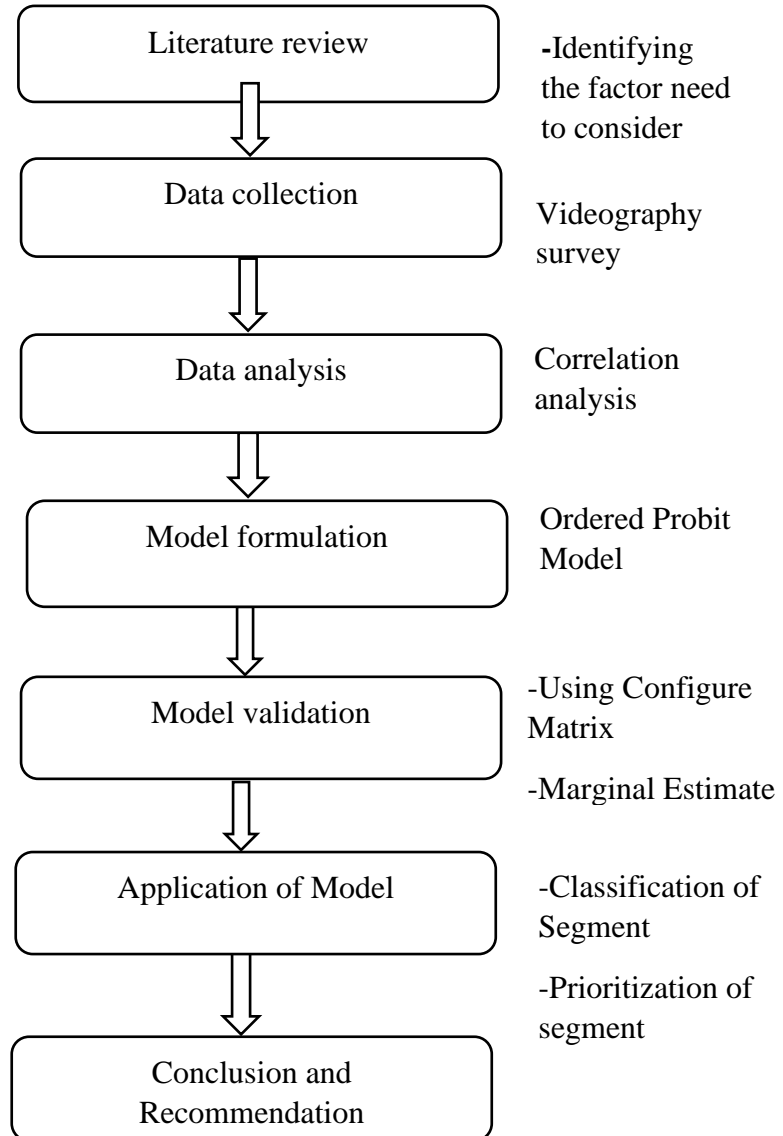


Figure 3. 1:Framework of Methodology

The initial step in the research design methodology was conducting a literature review to find out the attributes determining bicyclists' perception-based Level of Service (PLOS).

The selection of independent parameters in this study was driven by a comprehensive understanding of factors that influence bicyclists' perception-based Level of Service (PLOS), which was established through a thorough literature review. The aim was to identify variables that directly affect the bicyclist's perception of safety, comfort and the effort required for cycling under mixed traffic conditions. The parameters chosen—such as average traffic volume, average traffic speed, shoulder width, settlement type and on-street parking—were selected based on their documented impact in previous research on bicyclist LOS. The literature reviews also provided insights into the processes of data collection, extraction, and analysis. This review was an ongoing process throughout the research, conducted alongside data collection, extraction, analysis, model development, and validation. Finally, the results were analyzed, conclusions were drawn, and recommendations were presented.

3.2 Study area

Bharatpur is Metropolitan City in Chitwan District in the Bagmati Province. It covers an area of 429.46 square kilometers at the elevation of approximately 140 m to 390 m above sea level. Total population of Bharatpur Metropolitan City is 3,69,268 comprising 1,78,061 (48.4%) male and 1,90,542.28 (51.6%) female residing in 96,591 households. Bharatpur Metropolitan City has an average population density of around 853 people per sq. km (Census 2021).

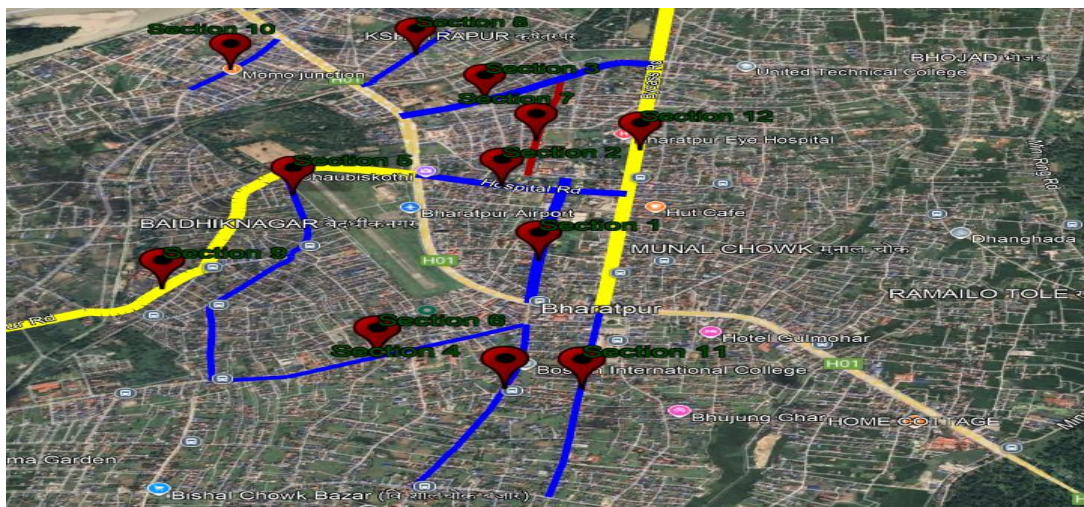


Figure 3. 2:Study Area

The study area is a highly dense and commercial road network of BMC, which are listed below in Table 3.1. This road sections covered different parts in total 12 homogenous road

section. A homogeneous section refers to a segment of the road where key influencing attribute i.e., average traffic volume, average traffic speed, shoulder width, pavement type, and on-street parking—remain relatively uniform. These sections are chosen to ensure that variations in bicyclists’ perception-based Level of Service (PLOS) are primarily due to controlled factors rather than abrupt changes in road conditions. Study sites distinct in terms of road geometry and traffic feature. This distinction reflects the diversity and complex nature of road in Bharatpur. The location of study area is shown in Figure 3.2.

Table 3. 1:List of Homogenous Road Section

S. N	Name of Description
Section 1	Hakim Chowk to Hospital Chowk
Section 2	Chowbiskoti to Malpot Chowk
Section 3	Birendrachowk to Bishalchowk
Section 4	Hakimchowk to Dharechowk
Section 5	Buddhachowk to Airportchowk
Section 6	Buddhachowk to Hakimchowk
Section 7	Hospitalchowk to Dipendrachowk
Section 8	Lionschowk to Kshetrapur
Section 9	Mangalpur to Trichowk
Section 10	Sahidchowk to Belchowk
Section 11	Paras Buspark to Shital Chowk
Section 12	Bypass Road

3.3 Data collection and extraction

Several roadway segments in bharatpur were identified which based on bicyclist trip data obtained from prior travel observation analysis, targeting road section with the relatively high number of bicycle trips. Following the defined data collection process, information for relevant independent variables was gathered from these segments to prepare the database. The identified variables were modified according to local conditions like perceived LOS (A-E). A summary of the variables and the data collection process is provided in Table 3.2.

Table 3. 2 Different Variable used in Model

S.N.	Variable	Variable type	Description
1	Perceived LOS	Continuous	5-point Likert scale (A, B, C, D, E)
2	Average Traffic Volume	Continuous	Average Traffic volume was no of vehicles collected at peak hour through video graphic survey at mid portion of roadway. Later it is counted manually frame by frame. $ATV=(V_c+V_{tw}\cdot PCU_{tw}+V_a\cdot PCU_a+V_{LCV}PCU_{LCV}+v_{HCV}\cdot PCU_{HCV})$ (IRC-108).
3	Average Traffic Speed	Continuous	Average speed of all vehicle is calculated. The average travel speed was calculated from video footage using a fixed trap length based on site conditions.
4	Shoulder Width	Continuous	Meter (Manually measured at every segment of road)
5	On-street Parking Proportion	Continuous	On-street parking calculated through total equivalent parked space by total available space for cycling. $ONP=(\text{total equivalent parked space})/\text{total space for bicycling}$
6	Settlement Type	Categorical	Roadside area having houses used only for living or absence of business assumed as Residential taken as 0 where other than residential like commercial and business taken as 1.
7	Pavement Type	Categorical	According to Present Serviceability Rating of HPMS system which classified road surface into 5 categories. (1,2,3,4 and 5) (FHWA,2018).

Attributes associated with model formulation like ATV, ATS and ONP are taken during the evening peak-hour time which is generally consider between time 4:00 to 6:00 PM, without accounting for temporal variations. Bicyclist weren't appearing in morning peak hour so it was discarded taking only evening peak hour traffic. This is due to most of bicyclist were worker who work as laborer of construction site went in early morning.

Likewise, student who uses bicycles also used to went early morning so they couldn't experience peak hour traffic of morning. The video graphic survey for collecting attributes data as well as travel intercept surveys were conducted simultaneously during the evening peak hour time to capture bicyclists' perception-based LOS(PLOS) for each section through questionnaire survey shown in Annex 2. This study relied on travel intercept survey to capture bicyclist preference among LOS where some study used recorded video of road section to capture bicyclist's rating.

The data collection methods outlined in the table employ a combination of manual measurements and video analysis to gather comprehensive traffic and roadway information. For Average Traffic Volume (ATV), peak hour classified volume counts were obtained at each midblock using both manual and video graphic techniques. In order to calculate average traffic volume a line in video were fixed, vehicle from both ways crossed the line counted manually. Traffic was counted for every 5 min interval and then converted into hourly volume. These counts were then converted into Passenger Car Units (PCUs) to standardize different vehicle types.

Average Traffic Speed, video footage was analyzed to calculate the average speed of all vehicles. This was done by measuring the time taken by vehicles to traverse fixed trap length, which was determined based on-site conditions. These trap length of road segment for speed calculation were 65m, 30.2m, 24.4m, 31.5m, 33.7m, 30.7m, 45.2m, 23.3m, 33.2m, 30.7m, 24m, 26.12m from segment 1 to 12 respectively. Each vehicle speed is determined dividing length by time (length=trap length, time=time taken to cross trap length), where time lapse was recorded by stopwatch initiate where the vehicle enters trap length and end when it leaves the trap length. Two or more vehicle enter and exit at the same time considered to be one. After calculating speed of each vehicles average traffic speed was determined by average speed of each category vehicle multiply with their percentage share of that category at every 5 min for example section 6 has 49% two-wheeler, 8% car, 18% Auto, 6% Bus and 19% Truck between the time 4:00 to 4:05 which further used to calculate the average velocity of section.

Shoulder width was measured manually at every 200m interval on both side of section. It is determined as the average value of taken over the homogeneous road section. For example, in section 10 having length 644m as per assumption three number of measurements is required so it taken as 1.5, 1.5, 1.55, 1.6, 1.6, 1.7 finally width of shoulder

in section 10 is 1.575. Likewise, shoulder width of other section were determined. Another important attribute of model is on-street parking which is calculated from unique methodology. In this method, all area of sections is considered to be available area for maneuvering for bicyclist. So on-street parking was calculated total area covered with no vehicles parked by total space of road including shoulder. Vehicles parked on roadside are counted in 5 min interval and averaged to determined overall on-street parking. For example, in section 2 no parked two-wheeler, Car, Auto, LCV and HCV were 56, 53, 20, 1 and Nil respectively between the time 4:10 to 4:15. So on street parking was calculated as dividing total parked area by total space available resulted as 0.1350.

Settlement Type was categorized based on land use, with residential areas denoted by 0 and non-residential areas by 1. Settlement was classified as residential where most of roadside houses used for living purpose and lesser for business purposes where roadside houses were commercial or business are grouped as non-residential. Pavement type basically classified according to Present Serviceability Rating of the Highway Performance Monitoring System (HPMS), which categorizes road surfaces into five type numbering 1 to 5, where 5 belong to excellent and 1 belong to worse. Pavement which has heavily rutting condition and more than 75 percent distress on road belongs to class 1. A road section has significant potholes, deep cracks and 50 percent distress on surface classified as 2. A road section having significant potholes, rutting and extensive overlay are considered to be class 3. Likewise, road section with smooth ride and exhibit few surfaces deterioration is assumed to be class 4. Moreover, superior pavements surface which was smooth enough and distress free were class 5.

The surveys were conducted immediately after respondents completed their trips on the respective segments. To ensure safety, participants were approached at the roadside for questioning. Considering that most Nepali bicyclists lack prior exposure to video-based surveys and may struggle to accurately perceive speed, vehicle interactions, and road conditions from recorded footage compared to real-time experience, this method was deemed unsuitable. Instead, face-to-face interviews were chosen as the primary survey tools.

A questionnaire survey conducted the surveys at the selected segments. Respondents were first asked about their willingness to participate. To enhance data quality, they were provided with background information about the study. To assess bicyclists' perceived

Level of Service (LOS), participants were asked to rate their cycling experience on the given road section using five categories: LOS A to LOS E. Before rating, they were provided with clear descriptions to help them understand each level. They were asked to imagine their experience while cycling and match it with the most appropriate LOS. LOS A represents a smooth, empty road with no traffic interference, where bicyclists feel completely safe and relaxed. LOS B describes conditions/ where a few vehicles are present, but they do not significantly impact comfort, allowing for a mostly pleasant ride. LOS C indicates moderate traffic, where bicyclists occasionally need to slow down or adjust their path, making the ride manageable but not ideal. LOS D reflects a challenging environment with heavy traffic, making cycling uncomfortable and requiring constant caution. Finally, LOS E signifies the most stressful conditions, where high traffic, on-street parking, and poor road conditions make cycling highly unsafe and difficult. By using these descriptions, bicyclists were able to express their perception of the road conditions they experienced.

Data from 12 segments in Bharatpur were utilized to formulate the bicyclists' perception-based LOS(PLOS) model. Minimum 35 bicyclists' responses were gathered per section, which represent more than 20% of bicyclists traveling along each roadway per day. Incomplete responses were excluded in model formulation, where 343 bicyclists input used for formulation. Whereas for model validation, 112 complete responses were used. A summary of the collected data from Bharatpur is provided in Table 3.3.

Table 3. 3 Summary of selected segment

Section	Name of Section	Length(km)	ATV (PCU/hr)	ATS(Km/hr)	HVP(%)	SW(m)	ONP	ST	PT
1	Hakim Chowk to hospital chowk	1.12	675.66	30.03	7.37%	0.375	0.0819	1	3
2	Chowbiskoti to Malpot Chowk	0.89	1041.3	25.71	7.07%	1.375	0.1709	1	4

3	Birendrachowk to Bishalchowk	1.24	734.5	27.21	5.70%	1	0.0696	1	4
4	Hakimchowk to Dharechowk	1.37	688.35	25.38	7.51%	2.02	0.065	0	3
5	Buddhachowk to Airportchowk	1.98	567.3	34.29	12.92%	1.81	0.0304	0	4
6	Buddhachowk to Hakimchowk	1.32	902.45	33.11	14.13%	2.41	0.039	1	5
7	HospitalChowk to Dipendrachowk	0.96	520	24	5.73%	0.305	0.1616	1	3
8	Lionschowk to kshetrapur	1.17	485.55	21.98	10.30%	1.12	0.0776	0	4
9	Mangalpur to Trichowk	6.10	734.6	41.38	17.51%	1.5	0.0069	0	3
10	Sahidchowk to Belchowk	0.65	1018.1	24.72	6.45%	1.575	0.3951	1	3
11	Paras Buspark to Shital Chow	1.49	302.5	22.2	7.87%	0.53	0.0701	0	4
12	Bypass Road Section	4.48	1091.22	30.77	28.83%	0.35	0.0844	1	5



Figure 3. 3: Questionnaire and Videography survey at study area

3.4 Sample size

The required sample size is calculated by Krejcie and Morgan's (1970) sample estimation technique at 95% confidence level and 5% marginal error. The formula is shown in equation (3.1).

$$n = \frac{X^2 * N * P * (1 - P)}{e^2 * (N - 1) + X^2 * P * (1 - P)} \quad (3.1)$$

Where, n= Sample Size

X^2 =Chi-square for the specified

N=Population Size

P =Population proportion

ME = Desired Margin of Error

Total bicyclist observed from 12 road section in evening peak hour period (4 to 6 pm) was 1917, number of bicyclists in those 12 homogeneous sections ranges from 74 to 254 where number of respondents were from 35 to 47 respectively. The sample size was determined based on field observations of bicyclist flow across different segments and by reviewing previous literature with similar research objectives and condition. Since the previous volume of bicyclist in bharatpur is absence minimum sample size is determined as overall bicyclist taken population size which is obtained 322 where, 455 complete responses from bicyclist, where 343 was used for model development and 112 for model validation.

3.5 Data analysis

3.5.1 Correlation analysis

Correlational analysis is used to examine the relationships between various roadway characteristics and bicyclist-perceived Level of Service (LOS). This method helps identify how strongly different factors like on-street parking (ONP), Average Traffic Volume (ATV), Average Traffic speed (ATS), Settlement Type (ST), Shoulder width (SW) and Pavement type (PT) are associated with bicyclist perceptions. The analysis uses Spearman's correlation test, a non-parametric measure suitable whether ordinal data used in the

research. It assesses the monotonic relationship between variables without assuming a normal distribution. This also helps to determine which factors are most influential in shaping bicyclist perceptions of road safety and comfort

3.5.2 Model development

Ordered Probit (OP) model to capture the ordered nature of the bicyclist-perceived LOS. The OP model is suitable for situations where the dependent variable is ordinal, meaning it reflects a ranked order (LOS A to E). The development begins with identifying relevant variables such as on-street parking (OP), Average Traffic Volume (ATV), Average Traffic speed (ATS), Settlement Type (ST), Shoulder width (SW) and Pavement type (PT), which are hypothesized to influence bicyclist perceptions. The OP model assumes a latent variable underlying the observed LOS categories, which is linearly related to the independent variables plus a random error term. Parameters are estimated using maximum likelihood estimation, which maximizes the probability of observing the given data under the specified model. The goodness-of-fit is assessed using pseudo-R-squared, which indicates how well the model explains the variability in perceived LOS.

Probit model basically used on the outcomes or dependent variables have two i.e binary outcomes where dependent variables has more than two outcomes OP model is used. Ordered probability models, whether probit or logit are constructed by introducing an unobserved variable z , which serves as the foundation for modelling the ordinal ranking of data. This latent dependent variable z is defined as a linear function specific to each observation:

$$z_i = \beta' X_i + \epsilon_i \dots\dots\dots \text{Eq-1}$$

where X = vector of variables determining the discrete ordering for n observations, β = vector of estimable parameters; and ϵ = random disturbance (Washington et al. 2011).

Based on Eq. (1), the observed ordinal data y /bicyclist-perceived LOS, which can take a value from A-E can be defined as follows:

- $y=1$, if $z \leq 0$ (LOS A)
- $y=2$, if $\mu_1 < z \leq 0$ (LOS B)
- $y=3$, if $\mu_2 < z \leq \mu_1$ (LOS C)

$y=4$, if $\mu_3 < z \leq \mu_2$ (LOS D)

$y=5$, if $z > \mu_3$ (LOS E)

where μ is referred to as the threshold parameter defining y . The threshold values in OP model corresponding to the cutoffs and indicate the change of perception of perceived LOS (Kadali and Vedagiri 2015). The μ parameters are jointly estimated along with β parameters. Hence, the estimation then becomes one of determining the probability of five specific ordered responses for each observation (Washington et al. 2011). For the stated purpose, an appropriate distribution of ε should be assumed. If the random disturbance or ε is assumed to be distributed normally across all observations with mean = 0 and variance = 1, then an OP model results with the following ordered choice probabilities:

$$P(y=1 \text{ or LOS A}) = \phi(0 - \beta X)$$

$$P(y=2 \text{ or LOS B}) = \phi(\mu_1 - \beta X) - \phi(0 - \beta X)$$

$$P(y=3 \text{ or LOS C}) = \phi(\mu_2 - \beta X) - \phi(\mu_1 - \beta X)$$

$$P(y=4 \text{ or LOS D}) = \phi(\mu_3 - \beta X) - \phi(\mu_2 - \beta X)$$

$$P(y=5 \text{ or LOS E}) = 1 - \phi(\mu_3 - \beta X)$$

3.5.3 Model validation

Model validation is done by testing of model with sets of data that represents the actual field conditions. 75% of data is used for model formulation and 25% for model validation. The primary reason for this division is to create a robust model while maintaining an independent dataset for evaluating its predictive performance. This approach helps in avoiding overfitting, where a model performs well on training data but fails to generalize to new data (Hastie, Tibshirani, & Friedman, 2009). Additionally, keeping a validation set is crucial for estimating generalization error, as it provides an unbiased measure of model performance (Kuhn & Johnson, 2013). The 75-25 split is widely used in transportation and behavioral studies to develop reliable models that reflect real-world conditions while allowing for validation to ensure accuracy and robustness (Washington, Karlaftis, & Mannering, 2011). The success-prediction rate, which compares predicted LOS with actual observations, is used to evaluate the model's accuracy.

CHAPTER 4: RESULT AND DISCUSSION

4.1 Summary of Variable

Maximum, mean, minimum and standard deviation of each category of Bicycle perceived based Level of service of Road is listed in Table 4.1.

Table 4. 1 Detailed statistics of each category

S.N	Variable	Unit/Scale	Min	Max	Mean	SD
1	Average Traffic Volume	PCU/hr	302.5	1091.2	727.4	235
2	Average Traffic Speed	Km/hr	21.98	41.38	27.21	5.55
3	On-Street Parking Proportion	Percentage	0.0069	0.3951	0.071	0.091
4	Shoulder Width	M	0.305	2.41	1.12	0.67

4.2 Demographic Insights

The survey data included 455 respondents, out of which 80.66% were male (367) and 19.34% were female (88) in Figure 4.1.

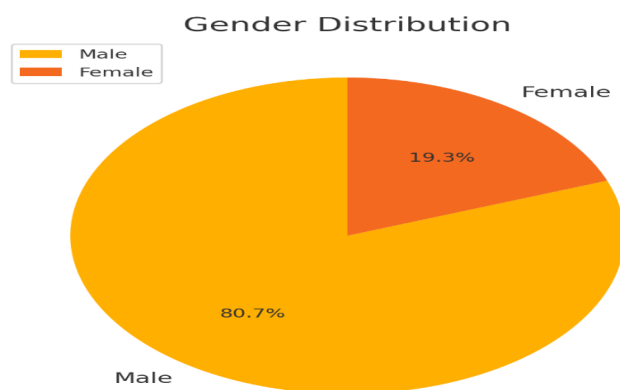


Figure 4. 1: Gender Distribution

The majority of bicyclist belonged to the younger age groups, with 22.86% under 18 years, followed by 20.88% in the 18–24 age group. Other age groups included 17.58% (25–34 years), 19.78% (35–44 years), 11.65% (45–54 years), 5.93% (55–64 years), and 1.32% older than 65 years also shown in Figure 4.2.

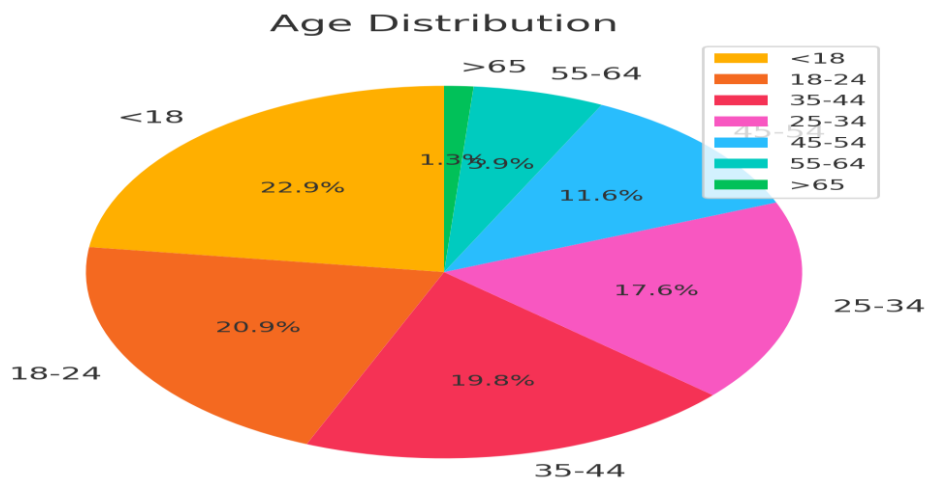


Figure 4. 2:Age Distribution

The dataset highlights a male-dominated group of cyclists, with the largest share of respondents being younger individuals. This distribution suggests that cycling is primarily popular among younger males, possibly due to their greater physical activity levels and mobility needs. The presence of older age groups indicates that cycling may also serve as a means of sustained physical activity or commuting among more experienced cyclists.

4.3 Travel Behaviour Patterns

The majority of respondents (59.12%) indicated that their primary purpose for cycling was work-related travel, followed by 16.48% for education, 11.65% for exercise, and 12.75% for short trips shown in Figure 4.3.

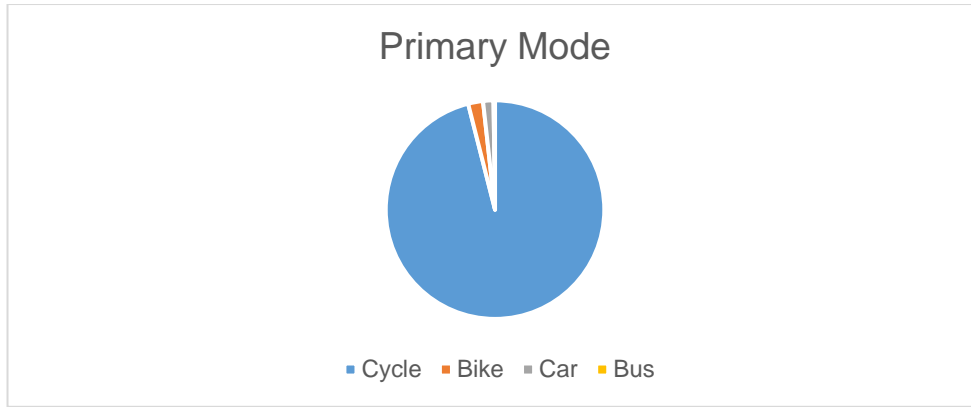


Figure 4. 3: Primary Mode of Transport Distribution

Regarding distance traveled, 53.63% of respondents cycle more than 35 km per week, while 23.30% travel between 20–35 km per week. Fewer participants reported shorter distances, with 16.48% cycling 10–20 km, 5.93% cycling 5–10 km, and only 0.44% traveling less than 5 km as shown in figure 4.4

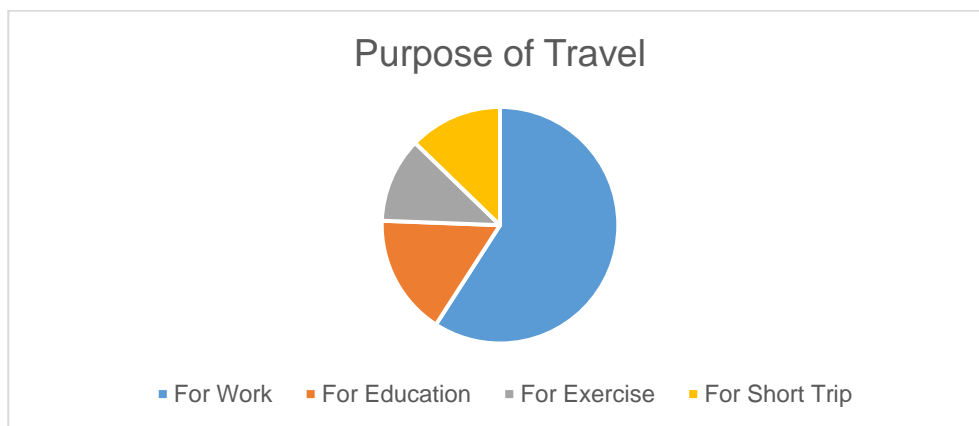


Figure 4. 4: Purpose of Travel

Additionally, 99.12% of respondents used cycles as their primary mode of transport, while motorcycles, cars, and buses were used by a very small proportion.

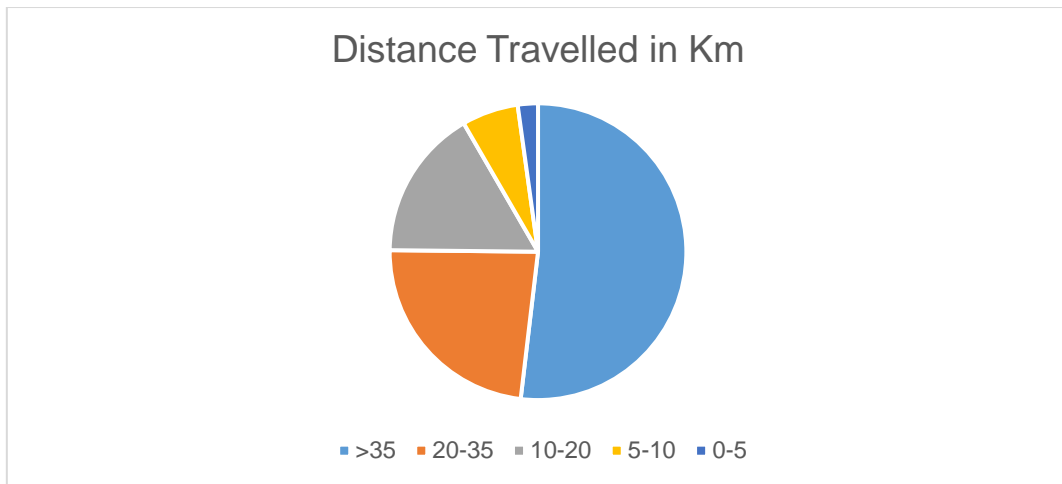


Figure 4. 5: Distance Travelled in Km

The results suggest that cycling in the study area is predominantly used for work purposes, reflecting its role as an essential commuting mode rather than purely recreational activity. The high percentage of respondents traveling distances (>35 km per week) indicates a dependence on cycling as a practical and economical transport option. Furthermore, the overwhelming preference for cycles (95.82%) underscores their accessibility and importance in daily travel within the study area.

4.4 Correlation analysis

Correlation between continuous independent, categorical independent and dependent-independent performed using Spearman, V-cramer test respectively in R-Software. Dependent and independent variable are listed in Table 4.2.

Table 4. 2 Dependent and independent variables for perceived LOS

Variable	Type	Nature of Variable
Perceived Level of Service	Dependent variable	Ordinal
Average Traffic Volume	Independent variable	Continuous
Average Traffic Speed	Independent variable	Continuous

On-street Parking	Independent variable	Continuous
Heavy Vehicle Percentage	Independent variable	Continuous
Shoulder Width	Independent variable	Continuous
Pavement Condition	Independent variable	Categorical
Settlement Type	Independent variable	Categorical

The correlation matrix was developed for both categorical is shown in Table 4.3. The V - Cramer test indicate that parameter wasn't correlated so both variables Pavement Condition and Settlement Type were considered for model development.

Table 4. 3 Correlation matrix of Categorical variables of PLOS

	Pavement Type(PT)	Settlement Type(ST)
Pavement Type(PT)	1	-0.078
Settlement Type(ST)	-0.078	1

The correlation matrix between continuous independent variable in Table 4.4 highlights that Average Traffic Volume (ATV) is moderately positively correlated with Heavy Vehicle Percentage (HVP) (0.398) and On-Street Parking (OP) (0.393), while Average Traffic Speed (ATS) shows a positively correlated with HVP (0.556) and a moderate correlation with ONP (-0.463). These results suggest that higher traffic volumes are associated with more heavy vehicles and on-street parking, while higher traffic speeds are linked to fewer parked vehicles but more heavy vehicles. Shoulder Width (SW) has weak correlations, indicating minimal influence on traffic characteristics overall.

Table 4. 4 Correlation matrix of Categorical variables of PLOS

	ATV	ATS	HVP	SW	ONP
ATV	1.000				
ATS	0.277	1.000			
HVP	0.398	0.556	1.000		
SW	0.261	0.329	-0.038	1.000	
ONP	0.393	-0.463	-0.348	-0.048	1.000

The correlation matrix of dependent variable i.e. Perceived level of service (PLOS) and independent variable Av_TrafficVol, Av_TrafficSP, HVP, SW, ONP, PT and ST is shown in Table 4.5. The spearman correlation between dependent variables and the independent variables indicated that they were also not strongly correlated with each other so all independent variables were considered for model development.

Table 4. 5 : Correlation matrix of dependent and independent variables of PLOS

	PLOS	ATV	ATS	HVP	SW	ONP	ST	PT
PLOS	1.00							
ATV	0.34***	1.00						
ATS	0.01***	0.49***	1.00					
HVP	-0.08***	0.16***	0.51** *	1.00				
SW	-0.15***	0.23***	0.32** *	0.23** *	1.00			
ONP	0.34***	0.23***	- 0.56**	- 0.49** *	- 0.49** *	1.00		
ST	0.33***	0.57***	0.09** *	-0.41**	-0.30**	0.580* **	1.00	

PT	-0.22***	0.07***	0.06** *	0.32** *	0.34**	- 0.31** *	- 0.08** *	1.00
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***;99% confidence Interval, **;95% confidence Interval; *:90% Confidence Interval

4.5 Model development and interpretation

The OP model was developed using R-script software package to determine the bicyclist perceived LOS based upon geometric and traffic characteristics. The ordered probit model represents the perceived LOS at 95% confidence interval. Here, Perceived LOS is taken as dependent variable and 6 variables in the form of Average Traffic Volume (ATV), Average Traffic Speed (ATS), On street Parking Proportion (ONP), Settlement Type (ST) and Pavement Type (PT) were taken as independent variables. To normalize the data for better model Traffic volume was divided by 1000 and Traffic speed was divided by 100.

Based upon the results presented by the software, the coefficients of parameters and the equation of ordered probit model represented as below:

Model I: Considering All Variables

Initially, the model is developed using all the variables significantly correlated with perceived level of service. Summary of respective models shown in Table 4.6 below:

Table 4. 6 : Summary of Model I (Considering all variables)

Variable	Estimate	Std-Error	z-value	Pr(> z)	Significance
ATV	0.97795	0.57723	1.694	0.09023	.
ATS	0.05805	0.0196	2.962	0.00306	**
HVP	-6.72704	2.17721	-3.09	0.002	**
SW	-0.36463	0.15346	-2.376	0.0175	*
ONP	1.95177	0.95961	2.034	0.04196	*
PT	0.20486	0.14368	1.426	0.15392	
ST	-0.47817	0.2527	-1.892	0.05846	.
A B	-0.1311	0.81	-0.162		
B C	1.3816	0.8071	1.712		
C D	2.5849	0.8120	3.184		
D E	4.0562	0.8291	4.892		
McFadden's Pseudo R ²			0.020		

The results show that traffic speed, heavy vehicle percentage, shoulder width, and on-street parking significantly impact perception. Among these, the presence of heavy vehicles (HVP) has the strongest negative effect ($\beta = -6.72704$, $p = 0.002$), meaning that even a slight increase in heavy vehicle percentage drastically increases the chance of cyclist's perceived higher LOS i.e LOSB. Shoulder width (SW) also negatively affects perception ($\beta = -0.36463$, $p = 0.0175$), but in this case, a wider shoulder improves LOS perception, as it provides more space and safety for cyclists. Similarly, on-street parking (ONP) negatively impacts the perceived LOS ($\beta = 1.95177$, $p = 0.04196$), likely because parked vehicles reduce available space and create hazards for cyclists, subsequently lower the perceived level of service i.e toward worse LOS.

Traffic speed (ATS) has a positive and significant effect ($\beta = 0.05805$, $p = 0.00306$), suggesting that cyclists perceive worsening LOS as higher traffic speed flows. Traffic volume (ATV) is marginally significant ($\beta = 0.97795$, $p = 0.09023$), showing a higher traffic volume may be associated with a lower perceived LOS—potentially due to lower space in congested areas. Similarly, settlement type (ST) is marginally significant ($\beta = -0.47817$, $p = 0.05846$), indicating that cyclists in residential areas tend to perceive a lower LOS, likely due to increased congestion and unpredictable vehicle movements. However, pavement type (PT) is not a significant predictor ($\beta = 0.20486$, $p = 0.15392$), implying that cyclists might prioritize space and traffic conditions over road surface quality.

The threshold coefficients in the OP Model define the cutoff points between different levels of perceived LOS. The A | B threshold (-0.1311) suggests that the transition from excellent (A) to good (B) LOS occurs at a slightly negative latent perception score. As conditions worsen, the B | C threshold (1.3816) marks the shift to LOS C, indicating a moderate decline in bicyclist perception. Further worsen leads to the C | D threshold (2.5849), where conditions are perceived as poor. Finally, the D | E threshold (4.0562) represents the point at which bicyclists perceive the worst LOS (E). These thresholds help classify responses based on the estimated latent variable, ensuring an ordered categorization of perceived level of service. The model's McFadden's Pseudo R^2 is low (0.0208), meaning that it explains only a small portion of the variation in perceived LOS.

The A | B threshold (-0.1311) is very close to zero, suggest that the distinction between LOS A and B is minimal. This implied that bicyclists did not perceive a strong difference between these two levels. Since the A | B threshold is close to zero and statistically

insignificant, it suggests that LOS A and B may not be meaningfully different in cyclists' perception. For improves model interpretability and statistical fit, combined A and B into a single category and named as LOSB. Hence, this model having low pseudo-R² and non-significant attributes warrant further exploration with significant attributes and threshold.

Model II: Considering Significant Variables in Model I

This model is developed using all the variables which are seen significant in Model I. In this model categorical variable Pavement Type (PT) and Threshold Cutoff A and B are excluded. Summary of respective model shown in Table 4.7 below:

Table 4. 7 :Summary of Model II (without Threshold A/B and PT)

Variable	Estimate	Std-Error	z-value	Pr(> z)	Significance
ATV	1.047	0.5678	1.844	0.06522	.
ATS	3.8099	1.3725	2.776	0.00551	**
HVP	0.5907	1.4603	0.404	0.68585	
SW	-0.3809	0.1202	-3.17	0.00153	**
OP	3.6047	0.845	4.266	1.99E-05	***
ST	0.1117	0.203	0.55	0.58218	
B C	1.1224	0.3452	3.251		
C D	2.5481	0.3586	7.106		
D E	3.8826	0.3812	10.186		
McFadden's Pseudo R ²				0.100599	

This ordered probit model-II results reveal the factors influencing bicyclists' perceived Level of Service (LOS). Among the significant attribute in previous model, traffic speed (ATS) has a strong positive and highly significant effect ($\beta = 3.8099$, $p = 0.00551$), suggesting that cyclists perceive worsen LOS as higher traffic speed flows as previous. Shoulder width (SW) remains a critical factor ($\beta = -0.3809$, $p = 0.00153$), where wider shoulders significantly improve perceived LOS, likely due to increased safety and space for cyclists. On-street parking (ONP) emerges as the most impactful variable ($\beta = 3.6047$, $p < 0.001$), indicating that the presence of parked vehicles significantly lowers cyclists' perceived LOS.

The effect of traffic volume (ATV) is marginally significant ($\beta = 1.047$, $p = 0.06522$), suggesting a weak positive relationship with LOS perception. Interestingly, heavy vehicle

percentage (HVP) is no longer significant ($\beta = 0.5907$, $p = 0.68585$), in contrast to previous models where it had a strong negative impact. This change suggests that heavy vehicle presence does not significantly alter cyclists' perception in the study area. Similarly, settlement type (ST) does not significantly affect perceived LOS ($\beta = 0.1117$, $p = 0.58218$), implying that road characteristics and traffic conditions have a greater influence on perception than residential or non-residential. The model's McFadden's Pseudo R^2 is low (0.10059), meaning that it was moderate model fit, which is common in perception-based studies.

The threshold coefficients indicate the transition points between different LOS categories, with higher values suggesting stronger influencing factors are required to move from one category to another. The threshold coefficients (B|C, C|D, D|E) are significant, confirming a clear distinction between different levels of perceived LOS. Regarding the collation of LOSA & B as LOSB is also justified as the B|C threshold was clear and significant. However, the overall model fit is relatively low which acceptable for complex human perception model but it implies the need for further refinement considering only significant attributes in this Model II.

Model III: Considering Significant Variables in Model II

This model is developed using all the variables which seen significant in Model II. In this model categorical variable Settlement type (ST) and continuous variable Heavy Vehicle Percentage (HVP) are excluded. Summary of respective model shown in Table 4.8 below:

Table 4. 8 : Summary of Model 3 (Excluding ST and HVP)

Variable	Estimate	Std-Error	z-value	Pr(> z)	Significance
ATV	1.31216	0.2955	4.441	8.97E-06	***
ATS	3.86062	1.31443	2.937	0.00331	**
SW	-0.42769	0.08434	-5.071	3.96E-07	***
OP	3.47298	0.74487	4.663	3.12E-06	***
B C	1.1304	0.3422	3.303		
C D	2.5554	0.3556	7.185		

D E	3.8904	0.3788	10.271		
McFadden's Pseudo R ²			0.1982		

The results of this ordered probit model-III indicate that higher traffic volume, traffic speed, and the presence of on-street parking significantly worsen bicyclists' perceived Level of Service (LOS). Traffic volume ($\beta = 1.31216$, $p < 0.001$) has a strong positive effect, meaning that as the number of vehicles increases, cyclists feel more discomfort, likely due to congestion, reduced manoeuvring space, and increased interaction with motor vehicles. Similarly, traffic speed ($\beta = 3.86062$, $p = 0.00331$) negatively impacts LOS, suggesting that faster-moving traffic makes cyclists feel unsafe, possibly due to a higher speed differential between bicycles and motor vehicles, increasing the risk of conflicts and accidents.

On-street parking ($\beta = 3.47298$, $p < 0.001$) also contributes significantly to a lower perceived LOS, as parked vehicles reduce the available cycling space and create potential hazards such as dooring incidents and crashes. In contrast, shoulder width ($\beta = -0.42769$, $p < 0.001$) has a negative coefficient, meaning that wider shoulders improve LOS by providing a safer and more comfortable riding environment, reducing cyclists' exposure to mixed traffic.

The threshold coefficients (B|C, C|D, D|E) in the Ordered Probit Model III define the boundaries between different levels of bicyclist's perception based Level of Service (PLOS). The threshold B|C (1.1304, $p < 0.01$) represents the point at which the perception shifts from LOS B to C, indicating a significant distinction between these categories. Similarly, C|D (2.5554, $p < 0.01$) marks the transition from LOS C to D, and D|E (3.8904, $p < 0.01$) defines the boundary between LOS D and E. The significance of all threshold coefficients confirms that bicyclists perceive distinct differences between the LOS categories, supporting the validity of using an ordered classification. The McFadden's Pseudo R² of model was 0.1982 indicates an improved model fit, suggesting that the independent variables explain approximately 19.82% of the variation in perceived LOS. This is a reasonable fit for perception-based models. So, this model was finalized as best suited model form based on datasheet of selected study areas.

The underlying latent score (z) based on final model of bicyclist's perception-based Level of Service (PLOS) can be seen in Table 4.9 in equation form with significant independent

variables Average Traffic Speed (ATS), Average Traffic volume (ATV), On-street Parking (ONP), and Shoulder Width.

Table 4. 9 Final model for Perceived LOS

$\text{Perceived LOS}(z) = 1.31 * \text{Average Traffic Volume (ATV)} + 3.860 * \text{Average Traffic Speed (ATS)} - 0.42 * \text{Shoulder Width (SW)} + 3.47 * \text{On-street Parking (ONP)}$

4.6 Model validation

Among 455 complete responses data, 112 (25% of total) data was used in validation. The model was validated through confusion matrix and showed in the form of a success-prediction table. The Ordered Probit Model achieved an overall accuracy of **52.6%**, indicating reasonable predictive performance for human perception-based model. The table shown that out of 28 observed LOSB this model is able to predict 17 of them correctly that in case of LOS C, 52 observed LOSC this model is able to predict 39 of them correctly. This model doesn't seem to be predicted enough to LOSD and LOSE. Hence, the model is fit to predict bicyclists' perception-based LOS.

Table 4. 10 Validation of OP Model with Success-Prediction Table

Predicted	Actual				Row sum	success rate(%)
	LOSB	LOSC	LOSD	LOSE		
LOSB	17	2	0	0	19	52.6%
LOSC	11	39	25	2	77	
LOSD	0	11	3	2	16	
LOSE	0	0	0	0	0	
Column sum	28	52	28	4	112	

4.7 Marginal Effect

Unlike linear regression, where coefficients directly show the impact of independent variables, the coefficients in an ordered probit model represent changes in the latent variable, not directly in probability terms so to calculate the significance of coefficient marginal effect analysis has to be done. Marginal effects are calculated for each variable to assess how changes in their magnitudes influence different levels of bicyclists perception-based level of service (PLOS). It mainly described how much % changed in Perceived LOS while changing 1% in attributes of model. The results, as presented in Table 4.11, provide insights into how each factor affects the likelihood of a particular LOS category being perceived. A positive coefficient of marginal effect implies that an increase in the variable rises the chances of bicyclists perceiving that specific LOS, while a negative marginal effect suggests a decrease in probability.

Table 4. 11 Summary of Marginal Effect

	ONP	ATV	SW	ATS
LOSB	-90.20	-27.92	12.63	-83.983
LOSC	-9.70	-4.20	1.19	-10.784
LOSD	92.88	21.24	-11.44	73.250
LOSE	19.36	2.47	-2.38	21.516

For example, the chances of perceiving LOB increased by 12.63% with the 1% increment in Shoulder width indicated that a unit increase in shoulder width rises the chances of bicyclists perceiving LOS B. To understand, detailed discussion of the effects on each attribute relating to bicyclist-perceived LOS is presented below.

4.7.1 Average Traffic Volume

As the increment in Average traffic volume (ATV) reduce the probability to perceive the better LOS. This marginal effect estimation indicated that negative effects on LOSB (-27.92) and LOSC (-4.20) whereas positive effect on LOSD (21.24) and LOSE (2.47). This implies that very high traffic volumes reduce the likelihood of a better LOS. This could be because heavy congestion slows down all road users, hinder to move smoothly and rise of

motor vehicle-bicycle interaction due to increment in traffic volume. Hence, bicycle travel should be protected from motor vehicle so that bicyclist feel comfort by providing necessary buffer like separate bicyclist from motor vehicle.

4.7.2 Shoulder Width

The marginal effect estimate of Shoulder width (SW) indicate that it enhances bicyclist comfort, as seen from its positive effects on LOSB (12.63) and LOSC (1.19). This result revealed that wider shoulders provide more space for bicyclists, improving their perceived safety and service quality. On the other hand, SW negatively impacts LOSD (-11.44) and LOSE (-2.38), meaning that increasing shoulder width decreases the likelihood of poor LOS. Hence, road section should be constructed with standard shoulder width which eventually increases to perceive better LOS due to safe and comfort manoeuvre of bicyclist.

4.7.3 Average Traffic Speed

The developed ordered probit model reveals that Average traffic speed (ATS) has a significant negative coefficient estimate, meaning that an increment in ATS rises the chances of bicyclists perceiving a LOS D or E. This indicates that higher vehicle speeds make bicyclists feel unsafe, leading to a lower perceived LOS. In contrast, ATS positively affects LOSD (73.25) and LOSE (21.52), supporting the idea that high-speed traffic conditions significantly worsen bicyclist perceptions.

4.7.4 On-Street Parking

On-street parking (ONP) has been identified as the most influential factor affecting bicyclist-perceived LOS among the variables analysed. The analysis shows that a 1% uplift in ONP leads to a 90.2% decrement in the chances of perceiving LOS B and a 9.7% similar in LOS C, indicating a significant reduction in bicyclist comfort. Conversely, the same 1% increase in ONP results in a 92.88% increase in the likelihood of LOS D and a 19.36% increase in the probability of LOS E, suggesting that more on-street parking severely worsens bicyclists' perceived service quality. This trend reflects the lack of dedicated parking facilities for motorized vehicles and bicycles in Bharatpur, leading to roadside and shoulder spaces being occupied by parked vehicles which typically used by bicyclists. The roadside parking combined with high traffic volume, creates a serious safety hazard for cyclists, further diminishing the suitability of these roads for bicycle travel.. These findings highlight the negative impact of ONP on bicycling conditions, particularly in urban environments where parked vehicles reduce available space and create obstacles for

cyclists. So dedicated parking space farther from roadside is necessary to improve LOS while strict law enforcement to illegal on-street parking may also help it.

4.8 Sensitivity Analysis

A sensitivity analysis of the model to evaluate the impact of each significant variable on the model's predictive accuracy. For doing this, four models were formulated with omission of one variable at a time. This implies a model having three parameters at a time, then the model's parameter coefficient and threshold cut-off is calculated. The findings from this sensitivity analysis are summarized in Table 4.12, providing insights into how the exclusion of each variable influences the model's performance.

Table 4. 12 Summary of Sensitivity Analysis of Model

OP Attributes	OP model without Average Traffic volume	OP model without Average Traffic Speed	OP model without Shoulder Width	OP model without On street Parking
ATV	-	1.73	1.08	2.09
ATS	6.70	-	2.25	-0.09
SW	-0.37	-0.37	-	-0.41
ONP	5.34	2.07	3.28	-
B C	1.26	0.27	1.02	0.26
C D	2.64	1.68	2.39	1.64
D E	3.96	3.00	3.60	2.94
Pseudo-p-squared	0.11	0.09	0.075	0.074
prediction-success rates (%)	52.00%	43.96%	42.07%	40.17%

The results indicate that OP models estimated without On-street parking (ONP) have a Macfadden r-square value of 0.074 and a predictive success rate of 40.17%, indicating that omitting ONP significantly affects model accuracy. So, a model without ONP is not best suited for model formulation. Among four models, a model not including Average Traffic Volume (ATV) has a higher pseudo-p-squared value of 0.11 and a 52.0% overall prediction success rate, suggesting that the model still performs well despite excluding ATV. This implies that

ATV data collection, which is resource-intensive, could be omitted for better predictive accuracy for bicyclist perception-based LOS in Bharatpur.

4.9 Application of Model

Bicyclist perception-based LOS model applied for the 12 selected road section in Bharatpur. According to the value of attributes from data extraction and equation-1 derived from model every segment is assigned to their respective z value. Using these inputs, the unobserved/latent variable z calculated and presented in Table 4.14 as follows

The model uses variables such as on-street parking proportion (ONP), Average Traffic Volume (ATV), Average Traffic Speed (ATS) and Shoulder Width (SW) to calculate a Z-value for each segment. Based on predefined thresholds, these Z-values are used to assign respective LOS grades presented in Table 4.10. For example, Segment 5, with an ONP of 0.0304, ATV of 0.567, SW of 1.81 and ATS of 0.3429, has a calculated Z-value of 1.4. Since this value was between the 1.13 and 2.55, thus the segment is assigned LOS C, indicating moderately good suitability for bicyclists.

Table 4. 13 Bicyclist-Perceived LOS Criteria

Bicyclist Perceived LOS	z-Score	Bicycle suitability
B	$Z < 1.13$	Good
C	$1.13 < Z < 2.55$	Moderately Good
D	$2.55 < Z < 3.89$	Bad
E	$Z > 3.89$	Very Bad

Among the 12 roadway segments analysed, none of segment achieved LOS B (good), while 10 segments were assigned LOS C (moderately good), 2 segments were graded as LOS D (poor). These findings reveal that the majority of segments fall into the poorer categories of LOS C or D, highlighting the suboptimal quality of bicycle travel infrastructure in the city. The results align with observed traffic conditions, where high traffic volume, higher

on-street parking proportion, narrow shoulder width and inadequate bicycle facilities contribute to the low LOS ratings.

The analysis underscores the urgent need for infrastructure improvements in Bharatpur. To achieve at least LOS B, which represents good condition for bicycle suitability, key interventions include reducing on-street parking, enhancing pavement and shoulder, and creating dedicated bicycle lanes. Addressing these factors is essential to improve the bicycling experience and promote sustainable transportation within the city.

Table 4. 14 Summary of Roadway Segments with Bicyclist Perceived LOS in Bharatpur

Segment	z score	Bicyclist Perception based LOS
1	2.170	C
2	2.364	C
3	1.828	C
4	1.245	C
5	1.400	C
6	1.567	C
7	2.040	C
8	1.276	C
9	1.944	C
10	2.989	D
11	1.271	C
12	2.763	D

The z-score, which represents an unobserved latent variable (z) can play a significant role in determining priority. Segments with higher z-scores need to be assigned higher priority rankings (lower perceived LOS). This is evident in segments 10 and 12, which have the

highest z-scores (2.989 and 2.763, respectively) and are ranked as the top two priorities. On the other hand, segment 4, with the lowest z-score (1.245), has the lowest priority ranking (12). The z-score serves as a strong indicator for prioritizing segments in terms of necessary improvements or interventions.

Table 4. 15 List of Roads with improvement priority

Segment	z score	Perceived LOS	Priority Rank
1	2.17	C	4
2	2.364	C	3
3	1.828	C	7
4	1.245	C	12
5	1.4	C	9
6	1.567	C	8
7	2.04	C	5
8	1.276	C	10
9	1.944	C	6
10	2.989	D	1
11	1.271	C	11
12	2.763	D	2

Moreover, the role of perceived LOS is crucial in determining the priority ranking. The segments categorized under LOS D (segments 10 and 12) are given the highest priority, indicating that bicyclists perceive these sections as the most challenging or unsafe. This implies that sections with poorer perceived service quality require urgent attention. In contrast, all other segments, which fall under LOS C, are ranked lower in priority, suggesting that while they may still require improvements, they are not as urgent as segments with LOS D. This prioritization aligns with the goal of addressing the most

problematic areas first to enhance the overall bicycling experience. The observed trends indicate a direct correlation between z-score and priority rank, meaning that the calculated z-score could be an effective metric for prioritizing road segments for improvements.

Overall, the findings emphasize the importance of integrating both quantitative measures (such as z-scores) and subjective perceptions (such as perceived LOS) when making decisions about roadway improvements for bicyclists. This approach ensures that improvements are directed toward the areas that need them the most, ultimately leading to better infrastructure planning and safer cycling conditions.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study presents a methodology for modelling bicyclist-perceived Level of Service (LOS) for roadway segments by considering various physical and functional roadway features specific to typical Nepali conditions. The developed Ordered Probit (OP) model proves to be an effective tool for analysing bicyclist perceptions across different LOS categories.

A review of previous research, combined with the results of this study, reveals that the factors influencing bicyclist-perceived LOS in Nepali contexts differ significantly from those observed in smooth or homogeneous traffic condition. While variables like Shoulder width and on-street parking (ONP) affect bicycle compatibility similarly in both contexts, their relative impacts are distinctly different. For example, ONP is a major deterrent to bicycle LOS in Nepali due to inadequate parking management, whereas it is less significant in developed countries. Traffic speed is also seen as a significant barrier to cycling in both developed and under-developed contexts. The OP model allows planners to evaluate segments for their bicycle suitability and suggest design changes when the predicted LOS is below an acceptable threshold, such as LOS C. Furthermore, the model applicable to better planning and prioritization of infrastructure improvements. Numerical results obtained from the models help to derive the following conclusions:

- A majority of bicyclist were male (85.3%).
- Youth bicyclist were 2 times more than compared to middle-age people.
- A half of bicycle travel were for work purpose.
- All variables weren't strongly correlated with each other i.e all correlation coefficient were less than 0.6
- Variables Settlement type, Pavement type and Heavy vehicle percentage were non-significant to model formulation.

- Average Traffic volume, Average Traffic Speed, on street parking effect negatively on perceived LOS where shoulder width impact positively to get better perceived LOS.
- The Mcfadden R^2 value obtained from the ordered probit model was found to be 0.1982, which indicates a good model for perception-based model.
- OP model can predict 52.6% overall accuracy where it can predict LOSB and LOSC correctly are 60.71% and 75% respectively.
- Marginal effect estimates indicate that on-street parking and average traffic speed have more influenced to get poorer LOS
- As the 1% change in ONP perceived LOS B decreased by 90.20%. In contrast shoulder width increased by unit raises probability of perceived LOS B by 12.63%.
- Sensitivity analysis indicated that on-street parking is most influential attributes, so model discarding it, is not best fitted.
- Sensitivity Analysis also show that omission Average traffic speed has larger pseudo-R-square and predicted more than model from other attributes omission so ATV has less predictive accuracy in bicyclist perception.
- Among the 12 analyzed roadway segments, none achieved LOS B (good). Instead, 10 segments were classified as LOS C (moderately good), while the remaining 2 segments were rated LOS D (poor).
- The segments classified as LOS D (segments 10 and 12) are assigned the highest priority, as bicyclists perceive these sections to be the most challenging and unsafe.

In this study attributes Pavement type, Settlement type and Heavy Vehicle percentage which are hypothesized to be impact on bicyclist perception in bharatpur became non-significant. Since all of the road section pavement surface was blacktopped and in good condition. So, bicyclist may not change their perception according to pavement type. Likewise, heavy vehicles percentage in bharatpur non-significant to bicyclist perception due to relatively lower volume. In bharatpur most impactful attribute is On-street parking which directly changes the perception of bicyclist. It also implies bicyclist perceive poor LOS i.e D or E if there is presence of high on street parking whether there is wider shoulder width. For example, section 10 has highest on-street parking and relatively lower speed and wider shoulder calculated bicyclist perceived LOS D.

Bicyclist perception-based LOS(PLOS) model it enables the identification of road segments that are most and least suitable for cycling, allowing planners to prioritize infrastructure improvements for segments with poor LOS. These applications ensure efficient use of resources and targeted interventions. In bharatpur the road section which has high on street parking and traffic volume ranked higher priority for improvement.

At last this research highlights the importance of incorporating user perception in roadway planning and suggests that improvements in shoulder width, management of on-street parking, and dedicated bicycle facilities can significantly enhance bicycling conditions. The methodology and findings of this study can also serve as a reference for similar cities aiming to promote sustainable and inclusive urban mobility.

5.2 Recommendation

The construction and prioritization of bicycle infrastructure, such as dedicated bicycle lanes to enhance the safety and comfort of bicyclists. The key factors that significantly influence bicyclist-perceived LOS specifically in bharatpur, such as on-street parking, high motorized vehicle volumes and Average traffic speed should be a primary focus. Among them on-street parking which is most influential regarding bicyclist regarding has to be improved. Vehicles have been parking illegally in some road section like section 5 and 12 strict law enforcement is required. While some road section needs proper management of this problem like vertical parking. This will help in two-way first bicyclist's perception for fear to accident due to dooring or crashes reduced and another more space for maneuvering will rises. Bicyclist are compelled to share the road section with motorized vehicle. In order to reduce such situation, increment in shoulder width may play a significant role. Mostly vehicles move onto the carriageway lie between the marked lane, if wider paved shoulder provided on both may also play a better role to perceive good LOS.

Data collection can be done through video-based techniques. Video based method involves capturing the perception of bicyclist from the riding video of road segment. In this method video of road segment riding experience present in video. Perception of non-bicyclist as well as bicyclist can be capture in this method. Real time perception have relatively lesser respondent than this method. Periodic assessments of roadway segments using the developed LOS criteria are recommended to identify areas needing intervention and to

track progress over time. Policy measures, including speed limits for motorized vehicles, stricter enforcement of traffic rules, and better management of on-street parking, should be implemented to create safer environments for bicyclists. Awareness campaigns can further promote the benefits of bicycling and encourage safe coexistence between bicyclists and motorized traffic.

The robustness of this bicyclist perceived LOS model could be increase by applying it to other cities in Nepal and similar developing/under developed countries to ensure its broader relevance and applicability. Finally, the LOS criteria should be used as a scientific framework for prioritizing investments in bicycle infrastructure, enabling efficient allocation of limited resources and driving sustainable urban development.

5.3 Future study

Future research could expand the analysis to encompass larger cities and rural areas to test the generalizability of the developed LOS criteria across different traffic and infrastructure settings. Incorporating temporal variations, such as changes in traffic patterns during different times of the day, seasons, and weather conditions, would enhance the robustness of the evaluation. Additionally, exploring the influence of bicyclist demographics, including age, gender, and cycling experience, could provide a more nuanced understanding of user perceptions and needs. Advanced survey techniques, such as video-based perception surveys or virtual reality simulations, could be employed to capture user feedback more accurately and realistically. The inclusion of additional variables, such as lighting conditions, roadway maintenance, signage quality, and enforcement of traffic regulations, could further refine the analysis.

Testing the LOS criteria in other under developed countries with similar traffic conditions would assess its transferability and applicability across diverse cultural and geographic contexts. The integration of LOS evaluation with real-time traffic monitoring systems and Geographic Information Systems (GIS) could enable dynamic assessment and prioritization of roadway segments for improvement. Longitudinal studies that evaluate the impact of implemented infrastructure enhancements on bicyclist-perceived LOS over time would provide valuable insights for policymakers and urban planners. Finally, future research could also examine the broader economic and environmental benefits of improved

bicycle infrastructure, including reduced traffic congestion, lower emissions, and enhanced public health outcomes, to support sustainable urban development initiatives.

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APPENDIX-A (SAMPLE OF QUESTIONNAIRE)

तपाइको उमेर कति हो ?(What is your age?)

1. १८ भन्दा मुनी(below 18)

2. १८-२४ सम्म (18-24)

3. २५-३४ सम्म (25-34)

4. ३५-४४ सम्म (35-44)

5. ४५-५४ सम्म(45-54)

6. ५५-६४ सम्म (55-64)

7. ६५ भन्दा माथी (Above 65)

२.तपाईको लिङ्ग कुन हो ?(What is your Gender?)

१.पुरुष(Male)

२. महिला(Female)

३.तपाईको आवतजावतको प्रमुख साधन कुन हो ?

१.बस वा अन्य (Bus or other Public Transort)

२.कार(Car)

३.साईकल (Cycling)

४.पैदल (Walking)

५. ट्याक्सी (Taxi)

४. तपाईंको साइकलिडको प्रमुख उदेश्य के हो ?

१. काम गर्न जानको लागि

२. पढ्न जानको लागि

३. कसरतको लागि

४. छोटो दुरी पार गर्नको लागि

५. अन्य साधन चढ्नको लागि

५. तपाईं साइकलिड हप्ताको कति गर्नु हुन्छ?

१. दैनिक

२. १-२ दिन

३. ३-४ दिन

४. ५-६ दिन

५. १ दिन भन्दा कम

६. तपाइ हप्ताको कति किलोमिटर दुरी साइकलमा यात्रा गर्नु हुन्छ?

१. ०-५ कि.मी

२.५-१० कि.मी

३.१०-२० कि.मी

४.२०-३५ कि.मी

५.३५ कि.मी भन्दा बढी

७.तपाईंको दृष्टिकोणमा यस सडक साइकलिडको लागी कस्तो छ?

१.धेरै नराम्रो(1)LOS E

२.नराम्रो(2) LOS D

३.ठिक छ(3) LOS C

४.धेरै ठिक छ(4) LOS B

५.उत्तम छ(5) LOS A

APPENDIX-B (SOURCE CODE-OP MODEL)

```
# Load necessary libraries
library(MASS)
library(readxl)

data <- read_excel("C:/new rabin/E/New folder/Proposal 3/Trial version
of/Trial3/Trial3A.xlsx")

# Install and load caret if not already installed
install.packages("caret")
library(caret)

# Set a random seed for reproducibility
set.seed(123)

# Create training (70%) and testing (30%) indices
train_indices <- createDataPartition(data$Perceived_LOS, p = 0.75, list = FALSE)

# Split the data
train_data <- data[train_indices, ] # Training set
test_data <- data[-train_indices, ] # Testing set

# Print the number of observations in each set
cat("Training set size:", nrow(train_data), "\n")
cat("Testing set size:", nrow(test_data), "\n")

# Ensure the dependent variable is an ordered factor
data$Perceived_LOS <- factor(data$Perceived_LOS, levels = c("B", "C", "D", "E"),
ordered = TRUE)
```

```

# Fit the ordered probit model

model_without_ST <- polr(Perceived_LOS ~ Av_TrafficVol +Av_TrafficSP +
HVP+SW+OP+PT,
      data = data, method = "probit")

# Summarize the model
summary(model_without_ST)
install.packages("writexl")
library(writexl)
summary_model_without_ST <- summary(model_without_ST)

# Extract coefficients, standard errors, and t-values
coefficients <- coef(summary_model_without_ST)
t_values <- coefficients[, "t value"]

# Calculate p-values
p_values <- 2 * pt(-abs(t_values), df = nrow(data) - length(t_values))

# Add significance levels
add_significance <- function(p) {
  if (p < 0.001) {
    return("***")
  } else if (p < 0.01) {
    return("**")
  } else if (p < 0.05) {
    return("*")
  } else {
    return("")
  }
}

significance <- sapply(p_values, add_significance)

```

```

# Create a results data frame
results <- data.frame(
  Variable = rownames(coefficients),
  Estimate = coefficients[, "Value"],
  Std_Error = coefficients[, "Std. Error"],
  t_value = t_values,
  p_value = p_values,
  Significance = significance
)

# Save results to an Excel file
write_xlsx(results, "Ordered_Probit_Results.xlsx")
cat("Results saved to 'Ordered_Probit_Results.xlsx'\n")

# Log-likelihood of the fitted model
logLik_fitted <- logLik(model_without_ST)
cat("Log-Likelihood of the model:", as.numeric(log_likelihoood), "\n")

# Fit a null (intercept-only) model
null_model_without_ST <- polr(Perceived_LOS ~ 1, data = data, method = "probit")

# Extract restricted log-likelihood
restricted_log_likelihoood <- logLik(null_model_without_ST)
cat("Restricted Log-Likelihood (Null Model):", as.numeric(restricted_log_likelihoood),
"\n")

# Fit the null model (intercept only)
null_model_without_ST <- polr(Perceived_LOS ~ 1, data = data, method = "probit")
logLik_null <- logLik(null_model_without_ST)

# Calculate McFadden's pseudo R-squared
pseudo_r2 <- 1 - as.numeric(logLik_fitted) / as.numeric(logLik_null)

```

```

# Display the result
cat("McFadden's Pseudo R-Squared:\n", round(pseudo_r2, 3), "\n")

# Extract coefficients and thresholds
coefficients <- coef(model)
thresholds <- model$zeta

# Print results
cat("Coefficients:\n")
print(coefficients)

cat("\nThresholds:\n")
print(thresholds)

# Predict probabilities on the test set
test_probs <- predict(model_without_ST, newdata = test_data, type = "probs")

# Predict categories on the test set
test_predictions <- predict(model_without_ST, newdata = test_data)

# Create a confusion matrix
conf_matrix <- table(Predicted = test_predictions, Actual = test_data$Perceived_LOS)

# Print the confusion matrix
cat("Confusion Matrix:\n")
print(conf_matrix)

# Calculate accuracy
accuracy <- sum(diag(conf_matrix)) / sum(conf_matrix)
cat("Model Accuracy on Test Set:", accuracy, "\n")

```

```

library(openxlsx)

# Load necessary library
library(dplyr)

# Load your dataset (replace 'your_data.csv' with the actual file)
df <- read_xlsx("C:/new rabin/E/New folder/Proposal 3/Trial version
of/Trial3/Trial3A.xlsx")

new_df <- df # here it was omit but later we remove na.omitt keep it below
summary(new_df)

# Extract coefficients
coef_trafficvol <- coef(model)["Av_TrafficVol"]
coef_trafficsp <- coef(model)["Av_TrafficSP"]
coef_sw <- coef(model)["SW"] # Shoulder Width
coef_op <- coef(model)["OP"]

# Extract threshold values
thresholds <- c(-Inf, model$zeta, Inf)

# Compute mean values of independent variables
avg_trafficvol <- mean(data$Av_TrafficVol)
avg_trafficsp <- mean(data$Av_TrafficSP)
avg_sw <- mean(data$SW)
avg_op <- mean(data$OP)

# Compute linear predictor (z) using average values
z <- coef_trafficvol * avg_trafficvol + coef_trafficsp * avg_trafficsp +
  coef_sw * avg_sw + coef_op * avg_op

# Compute marginal effects for Shoulder Width (SW)

```

```

marginal_effects_sw <- sapply(1:(length(thresholds)-1), function(k) {
  # Compute normal density at threshold points
  phi_k_minus_1 <- dnorm(thresholds[k] - z)
  phi_k <- dnorm(thresholds[k+1] - z)

  # Compute marginal effect for LOS category
  marginal_effect <- coef_sw * (phi_k_minus_1 - phi_k)

  # Convert to percentage
  marginal_effect_percentage <- marginal_effect * 100
  return(marginal_effect_percentage)
})

# Name the categories for clarity
names(marginal_effects_sw) <- c("LOSB", "LOSC", "LOSD", "LOSE")

# Print marginal effects in percentage
marginal_effects_sw

```

Compute marginal effects for Av_TrafficVol

```

marginal_effects_trafficvol <- sapply(1:(length(thresholds)-1), function(k) {
  # Compute normal density at threshold points
  phi_k_minus_1 <- dnorm(thresholds[k] - z)
  phi_k <- dnorm(thresholds[k+1] - z)

  # Compute marginal effect for LOS category
  marginal_effect <- coef_trafficvol * (phi_k_minus_1 - phi_k)

```

```

# Convert to percentage
marginal_effect_percentage <- marginal_effect * 100
return(marginal_effect_percentage)
})

# Name the categories for clarity
names(marginal_effects_trafficvol) <- c("LOSB", "LOSC", "LOSD", "LOSE")

# Print marginal effects in percentage
marginal_effects_trafficvol

# Compute marginal effects for OP
marginal_effects_op <- sapply(1:(length(thresholds)-1), function(k) {
  # Compute normal density at threshold points
  phi_k_minus_1 <- dnorm(thresholds[k] - z)
  phi_k <- dnorm(thresholds[k+1] - z)

  # Compute marginal effect for LOS category
  marginal_effect <- coef_op * (phi_k_minus_1 - phi_k)

  # Convert to percentage
  marginal_effect_percentage <- marginal_effect * 100
  return(marginal_effect_percentage)
})

```

```
# Name the categories for clarity
names(marginal_effects_OP) <- c("LOSB", "LOSC", "LOSD", "LOSE")

# Print marginal effects in percentage
marginal_effects_OP

# Calculate min, max, median, and standard deviation for all numeric variables
summary_stats <- df %>%
  summarise(across(where(is.numeric), list(
    Min = min,
    Max = max,
    Median = median,
    SD = sd
  )), na.rm = TRUE))

# Print the result
print(summary_stats)
```

APPENDIX-C (SAMPLE DATA)

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
1	1	25-34	M	Cycle	W	Daily	10-20	C	0.67	30.03	0.074	0.375	0.082	1	3
1	2	35-44	M	Cycle	E	Daily	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	3	<18	F	Cycle	E	Daily	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	4	18-24	M	Cycle	E	Daily	10-20	B	0.67	30.03	0.074	0.375	0.082	1	3
1	5	18-24	M	Cycle	W	Daily	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	6	55-64	M	Cycle	W	Daily	>35	D	0.67	30.03	0.074	0.375	0.082	1	3
1	7	18-24	M	Cycle	E	Daily	20-35	D	0.67	30.03	0.074	0.375	0.082	1	3
1	8	45-54	F	Cycle	W	Daily	10-20	D	0.67	30.03	0.074	0.375	0.082	1	3
1	9	18-24	M	Cycle	W	Daily	>35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	10	35-44	M	Cycle	E	Daily	10-20	C	0.67	30.03	0.074	0.375	0.082	1	3
1	11	<18	M	Cycle	E	Daily	10-20	C	0.67	30.03	0.074	0.375	0.082	1	3
1	12	35-44	M	Cycle	W	Daily	>35	B	0.67	30.03	0.074	0.375	0.082	1	3
1	13	<18	M	Cycle	E	Daily	10-20	C	0.67	30.03	0.074	0.375	0.082	1	3
1	14	18-24	M	Cycle	E	Daily	>35	A	0.67	30.03	0.074	0.375	0.082	1	3
1	15	45-54	M	Cycle	W	Daily	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	16	45-54	M	Cycle	W	Daily	>35	B	0.67	30.03	0.074	0.375	0.082	1	3
1	17	25-34	M	Cycle	W	1-2	>35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	18	35-44	F	Cycle	W	Daily	>35	D	0.67	30.03	0.074	0.375	0.082	1	3
1	19	45-54	M	Cycle	W	Daily	>35	D	0.67	30.03	0.074	0.375	0.082	1	3
1	20	>65	M	Bike	Ex	Daily	>35	B	0.67	30.03	0.074	0.375	0.082	1	3
1	21	<18	M	Cycle	S D	3-4	10-20	B	0.67	30.03	0.074	0.375	0.082	1	3
1	22	<18	F	Cycle	S D	3-4	5-10	B	0.67	30.03	0.074	0.375	0.082	1	3

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
1	23	35-44	M	Cycle	SD	Daily	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	24	35-44	M	Cycle	W	Daily	>35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	25	35-44	M	Cycle	W	Daily	>35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	26	18-24	F	Cycle	Ex	Daily	10-20	D	0.67	30.03	0.074	0.375	0.082	1	3
1	27	35-44	M	Cycle	W	Daily	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	28	35-44	M	Cycle	W	1-2	10-20	B	0.67	30.03	0.074	0.375	0.082	1	3
1	29	<18	M	Cycle	Ex	Daily	10-20	B	0.67	30.03	0.074	0.375	0.082	1	3
1	30	35-44	M	Cycle	W	Daily	10-20	C	0.67	30.03	0.074	0.375	0.082	1	3
1	31	35-44	M	Cycle	W	Daily	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	32	<18	M	Cycle	E	3-4	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	33	18-24	M	Cycle	W	Daily	10-20	C	0.67	30.03	0.074	0.375	0.082	1	3
1	34	<18	M	Cycle	W	5-6	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	35	<18	M	Cycle	E	5-6	10-20	D	0.67	30.03	0.074	0.375	0.082	1	3
1	36	25-34	M	Cycle	W	Daily	>35	A	0.67	30.03	0.074	0.375	0.082	1	3
1	37	25-34	M	Cycle	W	1-2	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	38	<18	M	Cycle	E	Daily	20-35	C	0.67	30.03	0.074	0.375	0.082	1	3
1	39	<18	M	Cycle	W	Daily	>35	D	0.67	30.03	0.074	0.375	0.082	1	3
1	40	18-24	M	Cycle	W	Daily	20-35	B	0.67	30.03	0.074	0.375	0.082	1	3
1	41	18-24	F	Cycle	SD	Daily	10-20	B	1.04	25.71	0.071	1.375	0.171	1	4
2	42	18-24	F	Cycle	Ex	Daily	>35	B	1.04	25.71	0.071	1.375	0.171	1	4
2	43	18-24	M	Cycle	W	Daily	>35	C	1.04	25.71	0.071	1.375	0.171	1	4
2	44	55-64	M	Cycle	W	Daily	>35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	45	<18	M	Cycle	SD	Daily	5-10	D	1.04	25.71	0.071	1.375	0.171	1	4
2	46	45-54	F	Cycle	W	Daily	20-35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	47	18-24	M	Cycle	E	Daily	20-35	C	1.04	25.71	0.071	1.375	0.171	1	4
2	48	18-24	M	Cycle	W	Daily	>35	B	1.04	25.71	0.071	1.375	0.171	1	4
2	49	18-24	F	Cycle	W	Daily	5-10	A	1.04	25.71	0.071	1.375	0.171	1	4
2	50	35-44	M	Cycle	W	Daily	>35	D	1.04	25.71	0.071	1.375	0.171	1	4

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
2	51	18-24	M	Cycle	E	Daily	20-35	A	1.04	25.71	0.071	1.375	0.171	1	4
2	52	18-24	M	Cycle	E	Daily	20-35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	53	>65	M	Bike	Ex	4-5	>35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	54	35-44	F	Cycle	W	Daily	20-35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	55	18-24	F	Cycle	E	Daily	20-35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	56	<18	M	Cycle	E	Daily	>35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	57	<18	M	Cycle	W	Daily	20-35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	58	55-64	M	Cycle	W	Daily	>35	C	1.04	25.71	0.071	1.375	0.171	1	4
2	59	<18	M	Cycle	W	Daily	10-20	C	1.04	25.71	0.071	1.375	0.171	1	4
2	60	35-44	M	Cycle	SD	Daily	10-20	C	1.04	25.71	0.071	1.375	0.171	1	4
2	61	35-44	M	Cycle	W	Daily	10-20	E	1.04	25.71	0.071	1.375	0.171	1	4
2	62	25-34	M	Cycle	W	Daily	20-35	C	1.04	25.71	0.071	1.375	0.171	1	4
2	63	25-34	F	Cycle	W	Daily	>35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	64	<18	F	Cycle	SD	Daily	5-10	D	1.04	25.71	0.071	1.375	0.171	1	4
2	65	25-34	M	Bike	Ex	Daily	>35	E	1.04	25.71	0.071	1.375	0.171	1	4
2	66	<18	M	Cycle	SD	3-4	>35	C	1.04	25.71	0.071	1.375	0.171	1	4
2	67	<18	M	Cycle	Ex	Daily	20-35	C	1.04	25.71	0.071	1.375	0.171	1	4
2	68	35-44	M	Cycle	W	Daily	20-35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	69	<18	M	Cycle	E	Daily	>35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	70	<18	M	Cycle	SD	Daily	>35	C	1.04	25.71	0.071	1.375	0.171	1	4
2	71	25-34	M	Cycle	W	5-6	>35	D	1.04	25.71	0.071	1.375	0.171	1	4
2	72	25-34	M	Cycle	Ex	Daily	>35	C	1.04	25.71	0.071	1.375	0.171	1	4
2	73	18-24	M	Cycle	W	Daily	20-35	C	1.04	25.71	0.071	1.375	0.171	1	4
2	74	18-24	F	Cycle	W	Daily	20-35	C	1.04	25.71	0.071	1.375	0.171	1	4
3	75	25-34	M	Cycle	W	Daily	>35	D	0.73	27.2	0.05	1.00	0.07	1	4
3	76	<18	M	Cycle	E	1-2	20-35	C	0.73	27.2	0.05	1.00	0.07	1	4
3	77	<18	M	Cycle	SD	1-2	>35	C	0.73	27.2	0.05	1.00	0.07	1	4
3	78	25-34	F	Cycle	SD	5-6	20-35	B	0.73	27.2	0.05	1.00	0.07	1	4

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
3	79	18-24	F	Cycle	SD	5-6	10-20	B	0.73	27.2	0.05	1.00	0.07	1	4
3	80	<18	M	Cycle	W	5-6	10-20	B	0.73	27.2	0.05	1.00	0.07	1	4
3	81	<18	M	Cycle	E	Daily	5-10	D	0.73	27.2	0.05	1.00	0.07	1	4
3	82	18-24	M	Cycle	W	Daily	>35	D	0.73	27.2	0.05	1.00	0.07	1	4
3	83	18-24	M	Cycle	SD	Daily	20-35	C	0.73	27.2	0.05	1.00	0.07	1	4
3	84	25-34	F	Cycle	SD	3-4	5-10	C	0.73	27.2	0.05	1.00	0.07	1	4
3	85	35-44	F	Cycle	W	Daily	20-35	C	0.73	27.2	0.05	1.00	0.07	1	4
3	86	<18	F	Cycle	E	Daily	10-20	C	0.73	27.2	0.05	1.00	0.07	1	4
3	87	18-24	F	Cycle	W	Daily	20-35	D	0.73	27.2	0.05	1.00	0.07	1	4
3	88	<18	M	Cycle	E	Daily	10-20	B	0.73	27.2	0.05	1.00	0.07	1	4
3	89	45-54	F	Cycle	W	Daily	>35	D	0.73	27.2	0.05	1.00	0.07	1	4
3	90	25-34	M	Cycle	W	Daily	20-35	B	0.73	27.2	0.05	1.00	0.07	1	4
3	91	25-34	M	Cycle	Ex	5-6	10-20	C	0.73	27.2	0.05	1.00	0.07	1	4
3	92	35-44	F	Cycle	W	Daily	>35	D	0.73	27.2	0.05	1.00	0.07	1	4
3	93	55-64	M	Cycle	Ex	Daily	20-35	B	0.73	27.2	0.05	1.00	0.07	1	4
3	94	45-54	M	Cycle	W	Daily	>35	C	0.73	27.2	0.05	1.00	0.07	1	4
3	95	35-44	M	Cycle	W	Daily	20-35	B	0.73	27.2	0.05	1.00	0.07	1	4
3	96	35-44	F	Cycle	W	3-4	>35	B	0.73	27.2	0.05	1.00	0.07	1	4
3	97	<18	M	Cycle	W	Daily	>35	A	0.73	27.2	0.05	1.00	0.07	1	4
3	98	45-54	M	Cycle	W	Daily	>35	C	0.73	27.2	0.05	1.00	0.07	1	4
3	99	45-54	M	Cycle	W	Daily	>35	E	0.73	27.2	0.05	1.00	0.07	1	4
3	100	18-24	F	Cycle	Ex	Daily	10-20	D	0.73	27.2	0.05	1.00	0.07	1	4
3	101	18-24	M	Cycle	E	Daily	20-35	C	0.73	27.2	0.05	1.00	0.07	1	4
3	102	18-24	F	Cycle	Ex	Daily	>35	B	0.73	27.2	0.05	1.00	0.07	1	4
3	103	25-34	M	Cycle	W	Daily	>35	D	0.73	27.2	0.05	1.00	0.07	1	4
3	104	18-24	M	Cycle	W	Daily	>35	B	0.73	27.2	0.05	1.00	0.07	1	4
3	105	35-44	M	Cycle	W	Daily	20-35	C	0.73	27.2	0.05	1.00	0.07	1	4
3	106	35-44	M	Cycle	W	Daily	10-20	C	0.73	27.2	0.05	1.00	0.07	1	4

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
3	107	18-24	M	Cycle	SD	Daily	5-10	D	0.73	27.2	0.05	1.00	0.07	1	4
3	108	18-24	M	Cycle	W	5-6	>35	C	0.73	27.2	0.05	1.00	0.07	1	4
3	109	18-24	F	Cycle	W	5-6	10-20	C	0.73	27.2	0.05	1.00	0.07	1	4
3	110	<18	M	Cycle	Ex	Daily	10-20	C	0.73	27.2	0.05	1.00	0.07	1	4
3	111	<18	M	Cycle	E	Daily	20-35	B	0.73	27.2	0.05	1.00	0.07	1	4
3	112	<18	M	Cycle	E	Daily	20-35	C	0.73	27.2	0.05	1.00	0.07	1	4
3	113	<18	M	Cycle	W	Daily	>35	D	0.73	27.2	0.05	1.00	0.07	1	4
3	114	18-24	M	Cycle	W	Daily	20-35	B	0.73	27.2	0.05	1.00	0.07	1	4
3	115	18-24	F	Cycle	SD	Daily	10-20	B	0.73	27.2	0.05	1.00	0.07	1	4
4	116	25-34	F	Cycle	W	Daily	>35	C	0.68	25.3	0.07	2.02	0.06	0	3
4	117	25-34	F	Cycle	W	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	118	18-24	F	Cycle	W	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	119	25-34	M	Cycle	W	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	120	45-54	M	Cycle	W	Daily	>35	A	0.68	25.3	0.07	2.02	0.06	0	3
4	121	<18	M	Cycle	W	Daily	>35	C	0.68	25.3	0.07	2.02	0.06	0	3
4	122	18-24	M	Cycle	W	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	123	<18	M	Cycle	W	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	124	45-54	M	Cycle	W	Daily	>35	D	0.68	25.3	0.07	2.02	0.06	0	3
4	125	25-34	M	Cycle	W	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	126	<18	M	Cycle	W	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	127	45-54	M	Cycle	W	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	128	18-24	M	Cycle	W	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	129	55-64	M	Cycle	W	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	130	<18	M	Cycle	E	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	131	45-54	M	Cycle	W	Daily	>35	A	0.68	25.3	0.07	2.02	0.06	0	3
4	132	18-24	M	Cycle	E	Daily	20-35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	133	18-24	M	Cycle	W	5-6	>35	B	0.68	25.3	0.07	2.02	0.06	0	3
4	134	<18	M	Cycle	W	Daily	10-20	B	0.68	25.3	0.07	2.02	0.06	0	3

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT	
4	135	<18	M	Cycle	W	Daily	5-10	C	0.68	25.3	0.07	2.02	0.06	0	3	
4	136	18-24	M	Bus	S	3-4	5-10	C	0.68	25.3	0.07	2.02	0.06	0	3	
4	137	18-24	M	Cycle	S	3-4	10-20	C	0.68	25.3	0.07	2.02	0.06	0	3	
4	138	45-54	M	Cycle	W	Daily	20-35	B	0.68	25.3	0.07	2.02	0.06	0	3	
4	139	>65	M	Car	Ex	Daily	>35	B	0.68	25.3	0.07	2.02	0.06	0	3	
4	140	<18	M	Cycle	E	Daily	>35	C	0.68	25.3	0.07	2.02	0.06	0	3	
4	141	<18	M	Cycle	S	D	Daily	5-10	C	0.68	25.3	0.07	2.02	0.06	0	3
4	142	25-34	F	Cycle	W	5-6	10-20	C	0.68	25.3	0.07	2.02	0.06	0	3	
4	143	<18	M	Cycle	E	5-6	>35	C	0.68	25.3	0.07	2.02	0.06	0	3	
4	144	45-54	M	Bike	Ex	5-6	>35	C	0.68	25.3	0.07	2.02	0.06	0	3	
4	145	25-34	F	Cycle	S	D	3-4	5-10	B	0.68	25.3	0.07	2.02	0.06	0	3
4	146	<18	M	Cycle	S	D	1-2	5-10	C	0.68	25.3	0.07	2.02	0.06	0	3
4	147	<18	M	Cycle	S	D	1-2	5-10	D	0.68	25.3	0.07	2.02	0.06	0	3
4	148	45-54	M	Cycle	W	5-6	>35	D	0.68	25.3	0.07	2.02	0.06	0	3	
4	149	18-24	M	Cycle	W	5-6	20-35	C	0.68	25.3	0.07	2.02	0.06	0	3	
5	150	25-34	M	Cycle	W	Daily	>35	C	0.56	34.2	0.12	1.81	0.03	0	4	
5	151	35-44	F	Cycle	W	Daily	>35	B	0.56	34.2	0.12	1.81	0.03	0	4	
5	152	35-44	M	Cycle	W	Daily	>35	B	0.56	34.2	0.12	1.81	0.03	0	4	
5	153	35-44	F	Cycle	W	Daily	5-10	D	0.56	34.2	0.12	1.81	0.03	0	4	
5	154	18-24	M	Cycle	W	Daily	>35	B	0.56	34.2	0.12	1.81	0.03	0	4	
5	155	<18	M	Bike	Ex	5-6	10-20	B	0.56	34.2	0.12	1.81	0.03	0	4	
5	156	<18	M	Bike	Ex	1-2	5-10	B	0.56	34.2	0.12	1.81	0.03	0	4	
5	157	18-24	M	Cycle	S	D	5-6	5-10	C	0.56	34.2	0.12	1.81	0.03	0	4
5	158	35-44	M	Cycle	W	Daily	>35	C	0.56	34.2	0.12	1.81	0.03	0	4	
5	159	45-54	M	Cycle	Ex	Daily	>35	C	0.56	34.2	0.12	1.81	0.03	0	4	
5	160	18-24	F	Cycle	E	Daily	20-35	B	0.56	34.2	0.12	1.81	0.03	0	4	
5	161	<18	M	Cycle	E	Daily	>35	B	0.56	34.2	0.12	1.81	0.03	0	4	
5	162	<18	M	Cycle	W	Daily	20-35	C	0.56	34.2	0.12	1.81	0.03	0	4	

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
5	163	55-64	M	Cycle	W	Daily	>35	C	0.56	34.2	0.12	1.81	0.03	0	4
5	164	<18	M	Cycle	W	Daily	10-20	B	0.56	34.2	0.12	1.81	0.03	0	4
5	165	35-44	M	Cycle	S/D	Daily	10-20	B	0.56	34.2	0.12	1.81	0.03	0	4
5	166	35-44	M	Cycle	W	Daily	10-20	A	0.56	34.2	0.12	1.81	0.03	0	4
5	167	25-34	M	Cycle	W	Daily	20-35	A	0.56	34.2	0.12	1.81	0.03	0	4
5	168	25-34	F	Cycle	W	Daily	>35	B	0.56	34.2	0.12	1.81	0.03	0	4
5	169	<18	F	Cycle	S/D	Daily	5-10	C	0.56	34.2	0.12	1.81	0.03	0	4
5	170	25-34	M	Bike	Ex	Daily	>35	C	0.56	34.2	0.12	1.81	0.03	0	4
5	171	<18	M	Cycle	S/D	3-4	>35	B	0.56	34.2	0.12	1.81	0.03	0	4
5	172	<18	M	Cycle	Ex	Daily	20-35	B	0.56	34.2	0.12	1.81	0.03	0	4
5	173	35-44	M	Cycle	W	Daily	20-35	B	0.56	34.2	0.12	1.81	0.03	0	4
5	174	<18	M	Cycle	E	Daily	>35	B	0.56	34.2	0.12	1.81	0.03	0	4
5	175	<18	M	Cycle	S/D	Daily	>35	B	0.56	34.2	0.12	1.81	0.03	0	4
5	176	25-34	M	Cycle	W	5-6	>35	A	0.56	34.2	0.12	1.81	0.03	0	4
5	177	25-34	M	Cycle	Ex	Daily	>35	B	0.56	34.2	0.12	1.81	0.03	0	4
5	178	18-24	M	Cycle	W	Daily	20-35	C	0.56	34.2	0.12	1.81	0.03	0	4
5	179	18-24	F	Cycle	W	Daily	20-35	B	0.56	34.2	0.12	1.81	0.03	0	4
5	180	25-34	M	Cycle	W	Daily	>35	C	0.56	34.2	0.12	1.81	0.03	0	4
5	181	<18	M	Cycle	E	1-2	20-35	C	0.56	34.2	0.12	1.81	0.03	0	4
5	182	<18	M	Cycle	S/D	10-20	>35	C	0.56	34.2	0.12	1.81	0.03	0	4
5	183	25-34	F	Cycle	S/D	5-6	20-35	B	0.56	34.2	0.12	1.81	0.03	0	4
5	184	18-24	F	Cycle	S/D	5-6	10-20	C	0.56	34.2	0.12	1.81	0.03	0	4
5	185	<18	M	Cycle	W	5-6	10-20	D	0.56	34.2	0.12	1.81	0.03	0	4
6	186	<18	M	Cycle	E	Daily	5-10	C	0.90	33.1	0.14	2.41	0.03	1	5
6	187	18-24	M	Cycle	W	Daily	>35	B	0.90	33.1	0.14	2.41	0.03	1	5
6	188	18-24	M	Cycle	S/D	Daily	20-35	A	0.90	33.1	0.14	2.41	0.03	1	5
6	189	25-34	F	Cycle	S/D	3-4	5-10	C	0.90	33.1	0.14	2.41	0.03	1	5
6	190	18-24	M	Cycle	Ex	Daily	>35	A	0.90	33.1	0.14	2.41	0.03	1	5

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
6	191	45-54	M	Bike	Ex	5-6	>35	B	0.90	33.1	0.14	2.41	0.03	1	5
6	192	35-44	F	Cycle	Ex	Daily	20-35	B	0.90	33.1	0.14	2.41	0.03	1	5
6	193	35-44	F	Cycle	W	Daily	>35	C	0.90	33.1	0.14	2.41	0.03	1	5
6	194	45-54	M	Cycle	W	Daily	>35	C	0.90	33.1	0.14	2.41	0.03	1	5
6	195	25-34	M	Cycle	W	Daily	>35	D	0.90	33.1	0.14	2.41	0.03	1	5
6	196	18-24	F	Cycle	E	Daily	>35	C	0.90	33.1	0.14	2.41	0.03	1	5
6	197	<18	M	Cycle	W	Daily	20-35	D	0.90	33.1	0.14	2.41	0.03	1	5
6	198	45-54	M	Cycle	W	Daily	20-35	D	0.90	33.1	0.14	2.41	0.03	1	5
6	199	<18	M	Cycle	E	Daily	10-20	D	0.90	33.1	0.14	2.41	0.03	1	5
6	200	<18	M	Cycle	E	Daily	10-20	D	0.90	33.1	0.14	2.41	0.03	1	5
6	201	25-34	M	Cycle	W	Daily	10-20	D	0.90	33.1	0.14	2.41	0.03	1	5
6	202	35-44	M	Cycle	W	Daily	>35	C	0.90	33.1	0.14	2.41	0.03	1	5
6	203	25-34	M	Cycle	W	Daily	20-35	D	0.90	33.1	0.14	2.41	0.03	1	5
6	204	45-54	F	Cycle	W	Daily	>35	D	0.90	33.1	0.14	2.41	0.03	1	5
6	205	<18	M	Cycle	W	Daily	10-20	C	0.90	33.1	0.14	2.41	0.03	1	5
6	206	<18	M	Bike	Ex	Daily	>35	C	0.90	33.1	0.14	2.41	0.03	1	5
6	207	<18	M	Cycle	SD	3-4	>35	C	0.90	33.1	0.14	2.41	0.03	1	5
6	208	<18	M	Cycle	Ex	Daily	20-35	B	0.90	33.1	0.14	2.41	0.03	1	5
6	209	18-24	M	Cycle	W	Daily	20-35	B	0.90	33.1	0.14	2.41	0.03	1	5
6	210	18-24	M	Cycle	E	Daily	>35	B	0.90	33.1	0.14	2.41	0.03	1	5
6	211	<18	M	Cycle	E	Daily	>35	D	0.90	33.1	0.14	2.41	0.03	1	5
6	212	25-34	M	Cycle	Ex	Daily	>35	A	0.90	33.1	0.14	2.41	0.03	1	5
6	213	35-44	M	Cycle	W	Daily	10-20	C	0.90	33.1	0.14	2.41	0.03	1	5
6	214	18-24	M	Cycle	E	Daily	>35	C	0.90	33.1	0.14	2.41	0.03	1	5
6	215	18-24	F	Cycle	W	Daily	20-35	B	0.90	33.1	0.14	2.41	0.03	1	5
6	216	35-44	M	Cycle	W	Daily	>35	D	0.90	33.1	0.14	2.41	0.03	1	5
6	217	35-44	F	Cycle	W	Daily	>35	B	0.90	33.1	0.14	2.41	0.03	1	5
6	218	<18	M	Cycle	W	Daily	>35	C	0.90	33.1	0.14	2.41	0.03	1	5

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
6	219	<18	M	Cycle	E	5-6	>35	C	0.90	33.1	0.14	2.41	0.03	1	5
6	220	18-24	F	Cycle	S/D	5-6	10-20	C	0.90	33.1	0.14	2.41	0.03	1	5
6	221	<18	M	Cycle	W	5-6	10-20	D	0.90	33.1	0.14	2.41	0.03	1	5
6	222	45-54	M	Cycle	W	5-6	20-35	B	0.90	33.1	0.14	2.41	0.03	1	5
6	223	<18	M	Cycle	E	Daily	>35	B	0.90	33.1	0.14	2.41	0.03	1	5
6	224	<18	M	Cycle	E	Daily	>35	C	0.90	33.1	0.14	2.41	0.03	1	5
7	225	<18	F	Cycle	E	Daily	>35	B	0.52	24.0	0.05	0.30	0.16	1	3
7	226	18-24	M	Cycle	W	Daily	>35	B	0.52	24.0	0.05	0.30	0.16	1	3
7	227	18-24	M	Cycle	E	Daily	>35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	228	18-24	M	Cycle	E	Daily	>35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	229	25-34	F	Cycle	W	Daily	>35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	230	18-24	M	Cycle	E	Daily	>35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	231	45-54	M	Cycle	Ex	Daily	>35	D	0.52	24.0	0.05	0.30	0.16	1	3
7	232	18-24	M	Cycle	E	Daily	>35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	233	25-34	M	Car	S/D	Daily	>35	B	0.52	24.0	0.05	0.30	0.16	1	3
7	234	>65	M	Cycle	S/D	3-4	10-20	C	0.52	24.0	0.05	0.30	0.16	1	3
7	235	35-44	M	Cycle	W	Daily	20-35	B	0.52	24.0	0.05	0.30	0.16	1	3
7	236	<18	M	Cycle	E	Daily	20-35	D	0.52	24.0	0.05	0.30	0.16	1	3
7	237	55-64	F	Cycle	W	Daily	>35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	238	45-54	M	Cycle	W	Daily	>35	D	0.52	24.0	0.05	0.30	0.16	1	3
7	239	35-44	F	Cycle	W	Daily	10-20	D	0.52	24.0	0.05	0.30	0.16	1	3
7	240	35-44	F	Cycle	S/D	3-4	5-10	C	0.52	24.0	0.05	0.30	0.16	1	3
7	241	25-34	M	Cycle	W	Daily	20-35	D	0.52	24.0	0.05	0.30	0.16	1	3
7	242	18-24	M	Cycle	W	5-6	>35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	243	18-24	F	Cycle	W	Daily	>35	D	0.52	24.0	0.05	0.30	0.16	1	3
7	244	35-44	M	Cycle	W	Daily	20-35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	245	<18	M	Cycle	W	Daily	20-35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	246	<18	M	Cycle	E	Daily	20-35	C	0.52	24.0	0.05	0.30	0.16	1	3

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
7	247	18-24	M	Cycle	W	Daily	20-35	B	0.52	24.0	0.05	0.30	0.16	1	3
7	248	35-44	M	cycle	W	Daily	10-20	C	0.52	24.0	0.05	0.30	0.16	1	3
7	249	45-54	M	Cycle	W	5-6	20-35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	250	25-34	M	Cycle	W	Daily	>35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	251	45-54	M	Cycle	W	Daily	>35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	252	<18	F	Cycle	E	Daily	>35	A	0.52	24.0	0.05	0.30	0.16	1	3
7	253	18-24	M	Cycle	W	Daily	10-20	D	0.52	24.0	0.05	0.30	0.16	1	3
7	254	<18	M	Cycle	SD	Daily	10-20	E	0.52	24.0	0.05	0.30	0.16	1	3
7	255	<18	M	Cycle	E	Daily	5-10	B	0.52	24.0	0.05	0.30	0.16	1	3
7	256	<18	M	Cycle	Ex	Daily	>35	B	0.52	24.0	0.05	0.30	0.16	1	3
7	257	18-24	M	Cycle	W	Daily	20-35	C	0.52	24.0	0.05	0.30	0.16	1	3
7	258	25-34	M	Cycle	W	Daily	20-35	D	0.52	24.0	0.05	0.30	0.16	1	3
7	259	35-44	M	Cycle	W	5-6	10-20	C	0.52	24.0	0.05	0.30	0.16	1	3
7	260	35-44	M	Cycle	W	Daily	>35	C	0.52	24.0	0.05	0.30	0.16	1	3
8	261	<18	F	Cycle	E	Daily	20-35	B	0.48	21.9	0.10	1.12	0.07	0	4
8	262	18-24	F	Cycle	E	Daily	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	263	35-44	M	Cycle	W	Daily	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	264	18-24	M	Cycle	E	Daily	20-35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	265	35-44	F	Cycle	W	Daily	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	266	45-54	M	Cycle	W	Daily	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	267	25-34	M	Cycle	Ex	Daily	>35	D	0.48	21.9	0.10	1.12	0.07	0	4
8	268	25-34	M	Cycle	W	Daily	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	269	25-34	F	Cycle	W	Daily	>35	D	0.48	21.9	0.10	1.12	0.07	0	4
8	270	25-34	M	Cycle	W	3-4	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	271	25-34	M	Cycle	W	Daily	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	272	18-24	M	Cycle	E	5-6	20-35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	273	18-24	F	Cycle	W	Daily	20-35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	274	25-34	M	Cycle	Ex	Daily	>35	D	0.48	21.9	0.10	1.12	0.07	0	4

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
8	275	18-24	M	Cycle	W	Daily	>35	D	0.48	21.9	0.10	1.12	0.07	0	4
8	276	35-44	M	Cycle	W	Daily	>35	D	0.48	21.9	0.10	1.12	0.07	0	4
8	277	55-64	M	Cycle	Ex	Daily	>35	B	0.48	21.9	0.10	1.12	0.07	0	4
8	278	45-54	M	Cycle	W	5-6	>35	D	0.48	21.9	0.10	1.12	0.07	0	4
8	279	25-34	M	Cycle	W	Daily	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	280	25-34	M	Cycle	W	Daily	20-35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	281	25-34	M	Cycle	W	Daily	>35	B	0.48	21.9	0.10	1.12	0.07	0	4
8	282	<18	F	Cycle	W	5-6	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	283	25-34	M	Car	Ex	3-4	>35	B	0.48	21.9	0.10	1.12	0.07	0	4
8	284	35-44	F	Cycle	W	Daily	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	285	45-54	M	Cycle	Ex	Daily	>35	D	0.48	21.9	0.10	1.12	0.07	0	4
8	286	18-24	M	Cycle	W	Daily	10-20	C	0.48	21.9	0.10	1.12	0.07	0	4
8	287	55-64	M	Cycle	W	Daily	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	288	18-24	M	Cycle	E	Daily	20-35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	289	35-44	M	Cycle	W	Daily	20-35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	290	<18	M	Cycle	S/D	3-4	10-20	B	0.48	21.9	0.10	1.12	0.07	0	4
8	291	<18	M	Cycle	W	Daily	>35	C	0.48	21.9	0.10	1.12	0.07	0	4
8	292	25-34	M	Cycle	S/D	Daily	>35	B	0.48	21.9	0.10	1.12	0.07	0	4
8	293	25-34	M	Cycle	W	Daily	10-20	C	0.48	21.9	0.10	1.12	0.07	0	4
8	294	45-54	M	Cycle	Ex	Daily	>35	B	0.48	21.9	0.10	1.12	0.07	0	4
8	295	45-54	M	Cycle	W	Daily	10-20	C	0.48	21.9	0.10	1.12	0.07	0	4
8	296	35-44	M	Cycle	Ex	Daily	>35	D	0.48	21.9	0.10	1.12	0.07	0	4
8	297	35-44	F	Cycle	W	Daily	>35	B	0.48	21.9	0.10	1.12	0.07	0	4
8	298	18-24	F	Cycle	E	Daily	10-20	C	0.48	21.9	0.10	1.12	0.07	0	4
9	299	55-64	F	Cycle	W	Daily	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	300	45-54	M	Cycle	W	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	301	<18	M	Cycle	W	Daily	10-20	D	0.73	41.3	0.17	1.50	0.007	0	3
9	302	55-64	M	Cycle	W	Daily	>35	B	0.73	41.3	0.17	1.50	0.007	0	3

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
9	303	25-34	M	Cycle	W	Daily	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	304	18-24	M	Cycle	W	Daily	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	305	18-24	M	Cycle	W	Daily	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	306	25-34	M	Cycle	W	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	307	55-64	M	Cycle	W	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	308	25-34	M	Cycle	W	Daily	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	309	25-34	F	Cycle	E	Daily	10-20	D	0.73	41.3	0.17	1.50	0.007	0	3
9	310	35-44	M	Cycle	W	Daily	20-35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	311	45-54	M	Cycle	W	Daily	>35	B	0.73	41.3	0.17	1.50	0.007	0	3
9	312	18-24	M	Cycle	SD	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	313	18-24	M	Cycle	SD	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	314	18-24	M	Cycle	W	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	315	35-44	M	Cycle	E	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	316	45-54	M	Cycle	W	Daily	20-35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	317	18-24	M	Cycle	E	Daily	20-35	E	0.73	41.3	0.17	1.50	0.007	0	3
9	318	25-34	F	Cycle	W	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	319	55-64	M	Cycle	SD	5-6	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	320	<18	M	Cycle	E	5-6	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	321	25-34	M	Car	Ex	3-4	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	322	<18	M	Cycle	W	Daily	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	323	45-54	M	Cycle	W	Daily	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	324	35-44	M	Car	Ex	Daily	>35	E	0.73	41.3	0.17	1.50	0.007	0	3
9	325	25-34	F	Cycle	W	Daily	10-20	C	0.73	41.3	0.17	1.50	0.007	0	3
9	326	45-54	M	Cycle	W	Daily	20-35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	327	55-64	M	Cycle	W	Daily	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	328	35-44	M	Cycle	W	Daily	20-35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	329	35-44	M	Cycle	W	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	330	35-44	M	Cycle	W	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
9	331	25-34	M	Cycle	W	Daily	>35	B	0.73	41.3	0.17	1.50	0.007	0	3
9	332	35-44	F	Cycle	W	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	333	45-54	M	Cycle	W	Daily	>35	B	0.73	41.3	0.17	1.50	0.007	0	3
9	334	55-64	M	Cycle	Ex	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
9	335	55-64	M	Cycle	W	Daily	>35	B	0.73	41.3	0.17	1.50	0.007	0	3
9	336	25-34	M	Cycle	E	Daily	>35	D	0.73	41.3	0.17	1.50	0.007	0	3
9	337	25-34	M	Cycle	W	Daily	>35	C	0.73	41.3	0.17	1.50	0.007	0	3
10	338	55-64	F	Cycle	W	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	339	<18	M	Cycle	E	Daily	10-20	C	1.01	24.7	0.06	1.57	0.39	1	3
10	340	45-54	M	Cycle	W	Daily	10-20	A	1.01	24.7	0.06	1.57	0.39	1	3
10	341	35-44	M	Cycle	W	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	342	25-34	F	Cycle	E	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	343	<18	M	Cycle	SD	3-4	5-10	C	1.01	24.7	0.06	1.57	0.39	1	3
10	344	18-24	M	Cycle	W	Daily	>35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	345	25-34	M	Cycle	W	Daily	>35	B	1.01	24.7	0.06	1.57	0.39	1	3
10	346	18-24	M	Cycle	Ex	Daily	>35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	347	18-24	M	Cycle	W	Daily	>35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	348	45-54	M	Cycle	W	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	349	25-34	M	Cycle	W	Daily	>35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	350	35-44	M	Cycle	W	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	351	35-44	F	Cycle	W	3-4	20-35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	352	25-34	M	Cycle	Ex	Daily	>35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	353	18-24	M	Cycle	W	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	354	35-44	M	Cycle	W	Daily	>35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	355	18-24	M	Cycle	W	Daily	20-35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	356	45-54	M	Cycle	W	Daily	>35	E	1.01	24.7	0.06	1.57	0.39	1	3
10	357	35-44	F	Cycle	W	Daily	10-20	D	1.01	24.7	0.06	1.57	0.39	1	3
10	358	45-54	M	Cycle	W	5-6	>35	D	1.01	24.7	0.06	1.57	0.39	1	3

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
10	359	35-44	M	Cycle	W	5-6	20-35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	360	35-44	M	Cycle	W	Daily	20-35	B	1.01	24.7	0.06	1.57	0.39	1	3
10	361	45-54	M	Cycle	W	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	362	<18	M	Cycle	W	Daily	>35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	363	35-44	M	Car	W	Daily	20-35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	364	25-34	F	Cycle	W	Daily	10-20	C	1.01	24.7	0.06	1.57	0.39	1	3
10	365	45-54	M	Cycle	W	Daily	20-35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	366	55-64	M	Cycle	W	Daily	>35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	367	35-44	M	Cycle	W	Daily	20-35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	368	35-44	M	Cycle	W	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	369	35-44	M	Cycle	W	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	370	25-34	M	Cycle	W	Daily	>35	B	1.01	24.7	0.06	1.57	0.39	1	3
10	371	35-44	F	Cycle	W	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	372	45-54	M	Cycle	W	Daily	>35	B	1.01	24.7	0.06	1.57	0.39	1	3
10	373	55-64	M	Cycle	Ex	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
10	374	55-64	M	Cycle	W	Daily	>35	B	1.01	24.7	0.06	1.57	0.39	1	3
10	375	25-34	M	Cycle	E	Daily	>35	D	1.01	24.7	0.06	1.57	0.39	1	3
10	376	25-34	M	Cycle	W	Daily	>35	C	1.01	24.7	0.06	1.57	0.39	1	3
11	377	<18	M	Cycle	W	Daily	>35	B	0.30	22.2	0.07	0.53	0.07	0	4
11	378	<18	M	Cycle	W	Daily	>35	D	0.30	22.2	0.07	0.53	0.07	0	4
11	379	>65	M	Cycle	Ex	Daily	10-20	C	0.30	22.2	0.07	0.53	0.07	0	4
11	380	<18	M	Cycle	W	Daily	>35	A	0.30	22.2	0.07	0.53	0.07	0	4
11	381	45-54	M	Cycle	Ex	Daily	>35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	382	55-64	M	Car	Ex	3-4	5-10	C	0.30	22.2	0.07	0.53	0.07	0	4
11	383	>65	M	Cycle	S D	Daily	20-35	B	0.30	22.2	0.07	0.53	0.07	0	4
11	384	18-24	M	Cycle	S D	Daily	10-20	D	0.30	22.2	0.07	0.53	0.07	0	4
11	385	<18	M	Cycle	W	Daily	>35	D	0.30	22.2	0.07	0.53	0.07	0	4
11	386	<18	M	Cycle	E	Daily	>35	C	0.30	22.2	0.07	0.53	0.07	0	4

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
11	387	<18	M	Cycle	E	Daily	>35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	388	25-34	M	Cycle	W	Daily	>35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	389	35-44	F	Cycle	W	Daily	>35	D	0.30	22.2	0.07	0.53	0.07	0	4
11	390	45-54	M	Cycle	W	Daily	>35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	391	35-44	M	Cycle	Ex	Daily	>35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	392	18-24	M	Cycle	E	Daily	5-10	C	0.30	22.2	0.07	0.53	0.07	0	4
11	393	18-24	M	Cycle	W	Daily	>35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	394	18-24	M	Cycle	W	Daily	20-35	D	0.30	22.2	0.07	0.53	0.07	0	4
11	395	55-64	M	Cycle	S/D	Daily	10-20	C	0.30	22.2	0.07	0.53	0.07	0	4
11	396	35-44	F	Cycle	W	Daily	10-20	D	0.30	22.2	0.07	0.53	0.07	0	4
11	397	45-54	M	Cycle	S/D	1-2	>35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	398	35-44	F	Cycle	W	5-6	20-35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	399	35-44	M	Cycle	W	Daily	>35	B	0.30	22.2	0.07	0.53	0.07	0	4
11	400	25-34	F	Cycle	S/D	Daily	20-35	D	0.30	22.2	0.07	0.53	0.07	0	4
11	401	45-54	M	Bike	Ex	Daily	10-20	C	0.30	22.2	0.07	0.53	0.07	0	4
11	402	25-34	F	Cycle	W	Daily	>35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	403	18-24	M	Cycle	W	Daily	>35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	404	45-54	M	Cycle	S/D	1-2	10-20	C	0.30	22.2	0.07	0.53	0.07	0	4
11	405	35-44	M	Cycle	W	Daily	>35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	406	35-44	M	Cycle	W	Daily	20-35	B	0.30	22.2	0.07	0.53	0.07	0	4
11	407	55-64	M	Cycle	S/D	Daily	>35	B	0.30	22.2	0.07	0.53	0.07	0	4
11	408	35-44	F	Cycle	W	Daily	20-35	C	0.30	22.2	0.07	0.53	0.07	0	4
11	409	25-34	M	Cycle	S/D	Daily	>35	B	0.30	22.2	0.07	0.53	0.07	0	4
11	410	35-44	M	Cycle	W	Daily	>35	A	0.30	22.2	0.07	0.53	0.07	0	4
11	411	18-24	M	Cycle	S/D	Daily	5-10	D	0.30	22.2	0.07	0.53	0.07	0	4
11	412	35-44	M	Cycle	Ex	Daily	5-6	D	0.30	22.2	0.07	0.53	0.07	0	4
11	413	25-34	M	Cycle	W	Daily	20-35	B	0.30	22.2	0.07	0.53	0.07	0	4
11	414	18-24	M	Cycle	E	Daily	20-35	C	0.30	22.2	0.07	0.53	0.07	0	4

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
11	415	35-44	M	Cycle	W	Daily	20-35	B	0.30	22.2	0.07	0.53	0.07	0	4
11	416	45-54	M	Cycle	W	Daily	>35	B	0.30	22.2	0.07	0.53	0.07	0	4
11	417	35-44	M	Cycle	E	Daily	20-35	C	0.30	22.2	0.07	0.53	0.07	0	4
12	418	<18	M	Cycle	E	Daily	20-35	C	1.09	30.7	0.28	0.35	0.08	1	5
12	419	25-34	M	Cycle	SD	Daily	5-10	B	1.09	30.7	0.28	0.35	0.08	1	5
12	420	<18	M	Cycle	E	1-2	0-5	B	1.09	30.7	0.28	0.35	0.08	1	5
12	421	<18	F	Cycle	Ex	1-2	0-5	B	1.09	30.7	0.28	0.35	0.08	1	5
12	422	55-64	M	Cycle	SD	Daily	>35	D	1.09	30.7	0.28	0.35	0.08	1	5
12	423	<18	M	Cycle	E	Daily	10-20	C	1.09	30.7	0.28	0.35	0.08	1	5
12	424	35-44	F	Cycle	W	Daily	>35	B	1.09	30.7	0.28	0.35	0.08	1	5
12	425	45-54	M	Cycle	Ex	Daily	>35	B	1.09	30.7	0.28	0.35	0.08	1	5
12	426	<18	M	Cycle	W	Daily	10-20	D	1.09	30.7	0.28	0.35	0.08	1	5
12	427	<18	M	Cycle	W	Daily	10-20	C	1.09	30.7	0.28	0.35	0.08	1	5
12	428	35-44	M	Cycle	W	Daily	>35	B	1.09	30.7	0.28	0.35	0.08	1	5
12	429	<18	M	Cycle	W	Daily	5-10	C	1.09	30.7	0.28	0.35	0.08	1	5
12	430	35-44	F	Cycle	W	Daily	>35	B	1.09	30.7	0.28	0.35	0.08	1	5
12	431	25-34	M	Cycle	SD	Daily	20-35	A	1.09	30.7	0.28	0.35	0.08	1	5
12	432	45-54	M	Cycle	Ex	Daily	>35	C	1.09	30.7	0.28	0.35	0.08	1	5
12	433	35-44	F	Cycle	W	Daily	>35	C	1.09	30.7	0.28	0.35	0.08	1	5
12	434	<18	M	Cycle	Ex	1-2	20-35	B	1.09	30.7	0.28	0.35	0.08	1	5
12	435	35-44	M	Cycle	W	Daily	20-35	E	1.09	30.7	0.28	0.35	0.08	1	5
12	436	35-44	M	Cycle	W	Daily	>35	C	1.09	30.7	0.28	0.35	0.08	1	5
12	437	25-34	F	Cycle	W	Daily	>35	C	1.09	30.7	0.28	0.35	0.08	1	5
12	438	55-64	M	Cycle	W	Daily	>35	B	1.09	30.7	0.28	0.35	0.08	1	5
12	439	<18	M	Cycle	W	Daily	>35	C	1.09	30.7	0.28	0.35	0.08	1	5
12	440	<18	M	Cycle	E	Daily	>35	B	1.09	30.7	0.28	0.35	0.08	1	5
12	441	18-24	M	Cycle	W	Daily	>35	C	1.09	30.7	0.28	0.35	0.08	1	5
12	442	18-24	M	Cycle	W	Daily	>35	B	1.09	30.7	0.28	0.35	0.08	1	5

Section	Respondent	Age	Gender	Primary Mode	Purpose	Frequency	Distance travelled	Perceived_LOS	ATV	ATS	HVP	SW	ONP	ST	PT
12	443	35-44	M	Cycle	SD	Daily	10-20	B	1.09	30.7	0.28	0.35	0.08	1	5
12	444	18-24	M	Cycle	W	1-2	10-20	B	1.09	30.7	0.28	0.35	0.08	1	5
12	445	18-24	M	Cycle	Ex	1-2	>35	B	1.09	30.7	0.28	0.35	0.08	1	5
12	446	35-44	F	Cycle	W	Daily	>35	A	1.09	30.7	0.28	0.35	0.08	1	5
12	447	35-44	M	Cycle	SD	1-2	10-20	B	1.09	30.7	0.28	0.35	0.08	1	5
12	448	25-34	M	Cycle	W	Daily	20-35	C	1.09	30.7	0.28	0.35	0.08	1	5
12	449	35-44	M	Cycle	W	Daily	10-20	C	1.09	30.7	0.28	0.35	0.08	1	5
12	450	25-34	M	Cycle	W	Daily	20-35	B	1.09	30.7	0.28	0.35	0.08	1	5
12	451	25-34	M	Cycle	W	Daily	>35	A	1.09	30.7	0.28	0.35	0.08	1	5
12	452	55-64	M	Cycle	W	1-2	>35	B	1.09	30.7	0.28	0.35	0.08	1	5
12	453	<18	F	Cycle	E	Daily	10-20	B	1.09	30.7	0.28	0.35	0.08	1	5
12	454	45-54	M	Cycle	W	Daily	20-35	C	1.09	30.7	0.28	0.35	0.08	1	5
12	455	55-64	M	Cycle	W	Daily	20-35	B	1.09	30.7	0.28	0.35	0.08	1	5

Average Traffic Volume calculation of Section 2

Start Time	End Time	Motorcycle	Car/4W,	Auto	LCV	HCV	Bicycle	Total (PCU)	Bike	Car	Auto	LCV	HCV
4:00	4:05	65	11	17	2	0	7	802.8	48.58%	16.44%	30.49%	4.48%	0.00%
4:05	4:10	78	10	9	10	0	10	897.6	52.14%	13.37%	14.44%	20.05%	0.00%
4:10	4:15	81	20	17	7	1	13	1132.8	42.90%	21.19%	21.61%	11.12%	3.18%
4:15	4:20	93	32	14	2	1	11	1215.6	45.90%	31.59%	16.58%	2.96%	2.96%
4:20	4:25	90	16	2	20	5	13	1300.8	41.51%	14.76%	2.21%	27.68%	13.84%
4:25	4:30	47	27	15	4	3	6	1002	28.14%	32.34%	21.56%	7.19%	10.78%
4:30	4:35	68	16	15	3	3	8	978	41.72%	19.63%	22.09%	5.52%	11.04%
4:35	4:40	75	11	17	14	4	4	1222.8	36.80%	10.79%	20.02%	20.61%	11.78%
4:40	4:45	68	13	11	3	1	9	812.4	50.22%	19.20%	19.50%	6.65%	4.43%
4:45	4:50	95	17	14	6	1	10	1119.6	50.91%	18.22%	18.01%	9.65%	3.22%

Start Time	End Time	Motorcycle	Car/4 W,	Auto	LCV	HCV	Bicycle	Total (PCU)	Bike	Car	Auto	LCV	HCV
4:50	4:55	69	19	20	9	1	8	1128	36.7 0%	20.2 1%	25.5 3%	14.3 6%	3.19 %
4:55	5:00	66	18	21	7	2	11	1112.4	35.6 0%	19.4 2%	27.1 8%	11.3 3%	6.47 %
5:00	5:05	74	16	17	9	4	10	1186.8	37.4 1%	16.1 8%	20.6 3%	13.6 5%	12.1 3%
5:05	5:10	83	27	20	3	7	11	1416	35.1 7%	22.8 8%	20.3 4%	3.81 %	17.8 0%
5:10	5:15	65	26	14	6	2	4	1083.6	35.9 9%	28.7 9%	18.6 0%	9.97 %	6.64 %
5:15	5:20	80	21	10	7	2	9	1074	44.6 9%	23.4 6%	13.4 1%	11.7 3%	6.70 %
5:20	5:25	75	11	12	5	3	6	952.8	47.2 3%	13.8 5%	18.1 4%	9.45 %	11.3 4%
5:25	5:30	67	13	17	3	2	13	928.8	43.2 8%	16.8 0%	26.3 6%	5.81 %	7.75 %
5:30	5:35	75	19	12	10	4	12	1174.8	38.3 0%	19.4 1%	14.7 1%	15.3 2%	12.2 6%
5:35	5:40	61	16	17	3	1	12	892.8	40.9 9%	21.5 1%	27.4 2%	6.05 %	4.03 %
5:40	5:45	79	17	14	5	1	10	1005.6	47.1 4%	20.2 9%	20.0 5%	8.95 %	3.58 %
5:45	5:50	63	19	12	9	2	15	1012.8	37.3 2%	22.5 1%	17.0 6%	16.0 0%	7.11 %
5:50	5:55	68	9	7	2	1	21	688.8	59.2 3%	15.6 8%	14.6 3%	5.23 %	5.23 %
5:55	6:00	85	13	9	1	1	6	849.6	60.0 3%	18.3 6%	15.2 5%	2.12 %	4.24 %
							239	1041.3					7.07 %

Average Traffic Speed calculation of Section 7

From	To	Motorcycle	Car	Auto	Bus	Truck	Motorcycle	Car	Auto	Bus	Truck	Weighted Speed	PCU/h	Density
4:00	4:05	30.8	21.7	19.6	0.0	0.0	49%	8%	18%	6%	19%	20.3	569	28
4:05	4:10	25.9	23.7	14.2	31.0	28.7	55%	4%	31%	3%	6%	22.5	563	25
4:10	4:15	30.6	22.4	19.3	0.0	23.0	45%	11%	31%	4%	8%	24.3	424	17
4:15	4:20	29.1	0.0	20.8	0.0	0.0	53%	10%	25%	4%	8%	20.6	463	22
4:20	4:25	30.6	0.0	0.0	0.0	29.5	56%	18%	16%	3%	7%	19.1	536	28
4:25	4:30	32.6	25.6	15.7	0.0	0.0	64%	6%	30%	0%	0%	27.1	385	14
4:30	4:35	31.3	29.8	24.8	0.0	0.0	53%	16%	21%	5%	5%	26.6	740	28
4:35	4:40	29.3	27.3	23.7	25.6	22.7	56%	16%	28%	0%	0%	27.4	617	23
4:40	4:45	28.1	13.4	20.4	19.1	0.0	55%	15%	26%	3%	0%	23.6	552	23

From	To	Motorcycle	Car	Auto	Bus	Truck	Motorcycle	Car	Auto	Bus	Truck	Weighted Speed	PCU/h	Density
4:45	4:50	27.2	23.2	18.4	0.0	0.0	55%	17%	28%	0%	0%	24.1	566	24
4:50	4:55	32.7	19.6	21.7	0.0	0.0	53%	17%	23%	0%	6%	25.9	618	24
4:55	5:00	30.0	18.0	20.3	0.0	0.0	66%	11%	23%	0%	0%	26.4	556	21
												24.00	549.1	

On-Street Parking Calculation of Section 10

Start Time	End Time	Parked Bike	Parked Car	Parked Auto	Parked LCV	Parked HCV	On street Parking
4:00	4:05	243	22	40	17		0.3905
4:05	4:10	243	23	40	18		0.3957
4:10	4:15	243	24	40	19		0.4009
4:15	4:20	243	25	40	20		0.4061
4:20	4:25	243	26	40	21		0.4113
4:25	4:30	243	27	40	22		0.4165
4:30	4:35	243	28	40	23		0.4217
4:35	4:40	243	29	40	24		0.4269
4:40	4:45	243	30	40	25		0.4321
4:45	4:50	243	31	40	26		0.4373
4:50	4:55	243	32	40	27		0.4424
4:55	5:00	243	33	40	28		0.4476
5:00	5:05	231	19	34	18	1	0.3711
5:05	5:10	231	19	34	18	1	0.3711
5:10	5:15	231	19	34	18	1	0.3711
5:15	5:20	231	19	34	18	1	0.3711
5:20	5:25	231	19	34	18	1	0.3711
5:25	5:30	231	19	34	18	1	0.3711
5:30	5:35	231	19	34	18	1	0.3711
5:35	5:40	231	19	34	18	1	0.3711
5:40	5:45	231	19	34	18	1	0.3711
5:45	5:50	231	19	34	18	1	0.3711
5:50	5:55	231	19	34	18	1	0.3711
5:55	6:00	231	19	34	18	1	0.3711
							0.3951