DETERMINATION OF VEHICLE AND PEDESTRIAN ROAD SERVICE LEVELS AND INVESTIGATION OF ROAD SAFETY IN ANKARA PROVINCE SOME SELECTED REGIONS

ANKARA İLİNDE SEÇİLEN BAZI BÖLGELERİN ARAÇ VE YAYA YOLU HİZMET SEVİYELERİNİN BELİRLENMESİ VE YOL GÜVENLİĞİNİN İNCELENMESİ

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Submitted to

Graduate School of Science and Engineering of Hacettepe University

as a Partial Fulfillment to the Requirements

for the Award of Degree of Master of Science

In Civil Engineering

2022

ABSTRACT

DETERMINATION OF VEHICLE AND PEDESTRIAN ROAD SERVICE LEVELS AND INVESTIGATION OF ROAD SAFETY IN ANKARA PROVINCE SOME SELECTED REGIONS

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June 2022, 162 pages

The number of people using vehicles and public transportation in cities is increasing day by day. In this study, vehicle and pedestrian road service levels were evaluated for Ankara, the capital city of Turkey. A total of 1197 hours of data were obtained by counting the 3-week pedestrian and vehicle service levels multiple times during the day from the camera footages in the Traffic Control Branch of Directorate of the Transportation Department in the Ankara Metropolitan Municipality in certain selected regions. These data were used in calculations for 11 different pedestrian level level determination methods and 1 vehicle road traffic level determination method. The counts were made in 3 weeks between 19.07.2021 - 25.07.2021, 02.08.2021 - 08.08.2021 and 09.08.2021 - 15.08.2021. The "Highway Capacity Manual (HCM)" method was applied to determine the vehicle road service level for the capital. in order to determine pedestrian road service levels, “Highway Capacity Manual (HCM)”, “Landis”, “Mozer”, “Tan

Dandan”, “Disabled PLOS”, “Sarkar”, “Trip Quality”, “Gainesville”, “Conjoint Analysis”, “Australian” and “Traffitec” methods were applied. In line with the results obtained, firstly the methods were compared within themselves, then different methods were compared with each other, hours, days and weeks were compared with each other. In line with the results, improvement suggestions were tried to be presented where deemed necessary for the optimal result, and suggestions were made for studies for new pedestrian level of service evaluation methods that can be studied in the future.

Keywords: Road, Sidewalk, Level of Service (LOS), Road Service Level, Pedestrian Road Level of Service (PLOS), Vehicle and Pedestrian Level of Service Evaluation Methods.

ÖZET

ANKARA İLİNDE SEÇİLEN BAZI BÖLGELERİN ARAÇ VE YAYA YOLU HİZMET SEVİYELERİNİN BELİRLENMESİ VE YOL GÜVENLİĞİNİN İNCELENMESİ

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Haziran 2022, 162 sayfa

Şehirlerdeki araç ve toplu taşıma kullanan insan sayısı günden güne artış göstermektedir. Bu çalışmada, Türkiye'nin başkenti olan Ankara ili için araç ve yaya yolu hizmet seviyeleri değerlendirilmiştir. Seçilen belli bölgelerde Ankara Büyükşehir Belediyesinde Ulaşım Daire Başkanlığına bağlı Trafik Kontrol Şube Müdürlüğünde 3 haftalık yaya ve araç hareketlilik seviyeleri kamera görüntülerinden gün içerisinde birden çok kez sayılarak, toplamda 1197 saatlik veri alınmıştır. Bu veriler 11 farklı yaya yolu hizmet seviyesi belirleme metodunda ve 1 araç yolu trafik seviyesi belirleme metodu için hesaplarda kullanılmıştır. Yapılan sayımlar 19.07.2021 – 25.07.2021, 02.08.2021 – 08.08.2021 ve 09.08.2021 – 15.08.2021 tarihleri arasındaki 3 haftada gerçekleştirilmiştir. Başkent için araç yolu servis hizmet seviyesi belirlemek adına "Highway Capacity Manual (HCM)" metodu uygulanmıştır. Yaya yolu hizmet seviyelerinin belirlenmesi adına "Highway Capacity Manual (HCM)", "Landis", "Mozer", "Tan Dandan", "Disabled PLOS", "Sarkar", "Trip Quality", "Gainesville", "Conjoint Analysis", "Australian" ve "Traffitec" metotları uygulanmıştır. Başkentte uygulanan bu farklı metotlar karşılaştırılmıştır. Elde edilen sonuçlar doğrultusunda öncelikle metotlar kendi

içlerinde analiz edilmiş ardından farklı metotlar birbirleri ile kıyaslanırken, saatler, günler ve haftalar birbirleri ile kıyaslanmıştır. Çıkan sonuçlar doğrultusunda optimal sonuç için, gerekli görülen yerlerde iyileştirme önerileri sunulmaya çalışılmış ve gelecekte tasarlanabilecek yeni yaya yolu hizmet seviyesi belirleme yöntemleri için çalışmalarına öneriler oluşturulmuştur.

Anahtar Kelimeler: Yol, Kaldırım, Servis Hizmet Seviyesi, Yol Hizmet Seviyesi, Yaya Yolu Hizmet Seviyesi, Araç ve Yaya Yolu Hizmet Seviyesi Hesaplama Yöntemleri.

ACKNOWLEDGMENT

Prior to anything else, I would want to express my deepest appreciation to my supervisor, Asst. Prof. Dr. Elif ÇİÇEK, for her unending support. This thesis would not have been possible without her guidence, patience, motivation and vast knowledge. It has been a true joy and honor to work with her.

I want to express my heartfelt gratitude to Prof. Dr. M. Vefa AKPINAR, Prof. Dr. Murat KARACASU, Prof. Dr. Serhat KÜÇÜKALİ and Assoc. Prof. Dr. Alper Aldemir as jury members, for their helpful comments. It has been an honor to have them on my jury committee.

I would like to thank to Ankara Metropolitan Municipality Transportation Management Department for their valuable helps during this study.

I would want to thank my mother, who was my first instructor, my father, who has always supported me throughout my life, and my sister, who has always been a source of inspiration for me.

I would like to express my deepest gratitude to my significant other Aslı Bike KARAKUŞ for the patience, courage and support she showed me on this path.

Finally, I would like to thank my friends Özgün BOZDOĞAN, Deniz YÜKSEL, Irmak GÜNAL, Görkem Alp GÖRKEM, Ece KARAKUŞ, Alihan TURAN and Sedanur ŞEN for their endless support and valuable assistance during this process.

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SYMBOLS

Symbols

A1	Kızılay 1st Selected Region
A2	Kızılay 2nd Selected Region
A3	Kızılay 3rd Selected Region
A4	Dutluk Region
A5	Keçiören Region
A6	Kızlar Pınarı Region
A7	Demet Region
A8	Kurtuluş Region
A9	Pursaklar Region
A10	Dikimevi Region
q	Flow (veh/h)
u	Speed (km/h)
k	Density (veh/km)
f_{LW}	Adjustment for lane width
f_{LC}	Adjustment for lateral clearance
f_M	Adjustment for median type
f_A	Adjustment for the number of access points along the roadway
TLC	Lateral clearance in meters,
LC_R	Lateral clearance on right,
LC_L	Lateral clearance on left.
v_p	15-min passanger car equivalent flow rate (pc/h/ln)
V	Hourly volume for hour of analysis (veh/h)
N	Number of lanes

f_{HV}	Heavy-vehicle modification factor
f_p	Driver population factor
V_{15}	Maximum 15-min volume within the hour of analysis
P_T	Percentage of trucks
P_R	Percentage of RVs
E_T	Passenger car equivalent for trucks
E_R	Passenger car equivalent for RVs
f_G	Grade adjustments factor
f_{np}	Adjustment factor for no passing zones
W_E	effective walkway width (m)
W_T	total walkway width (m)
W_O	sum of widths and lengths from obstacles to the edge(m)
v_{ped}	Pedestrian unit flow rate (p/min/m)
W_{ol}	Width of the outer lane (feet),
W_l	Shoulder or bike lane width (feet),
f_p	coefficient of effect of on-street parking
$\%OSP$	% of section with on-street parking
f_b	Buffered area barrier coefficient
W_b	buffer width (feet)
W_s	sidewalk width (feet)
Vol_{15}	The average volume of traffic within a 15-minute interval.
L	number of total (through) lanes (for road or street)
SPD	average speed of vehicular traffic (mph)
f_{sw}	sidewalk existence coefficient
PHV	Peak hour pedestrian volume

NPM	Mode split that is none pedestrians
WWA	The width of the pedestrian walkway in meters.
TP	Travel Pattern Factor
FD	Facility Design Factor
WBW	Walkarea-Outside Lane Buffer Width
EQ	Aesthetic Quality
ADT	Average Daily Traffic
K	Percentage of ADT that happens during the peak hour
LN	Quantity of lanes
ND	Number of Driveways
APHP	Peak Hour Average Penetrations per Driveway
D	The segment's length in meters.
Q_B	Bicycle traffic within a five-minute interval
Q_P	Pedestrian traffic within a five-minute interval
Q_V	Vehicle traffic within a five-minute interval (pcu)
P	Quantity of driveway access per meter
W_r	Distance between walkway and car lane (m)
i	Indicator number;
c	Coefficient of disabled pedestrian indicator
DI	Disabled pedestrian indicator score
$logit(p)$	Cumulative logit model utility function,
α	Intercept parameter of the satisfaction level response,
WA	Type of walking area,
AREA	Type of roadside development or landscape,
MOT	Motor vehicles per hour in either direction

SPEED	Average motor vehicle speed (km/h)
PED	Passed people per hour
BIKE	Bicycles and motorized scooters per hour in either direction
BUF	Width between the pedestrian area and the driving lane (meters)
PARK	Number of parked vehicles per 100 meters
MED	Median dummy
SB	walking area width (meters)
BL	Total width of the walking area and the closest driving lane
LANE	Driving lane dummy
TREE	Tree dummy
s	Standard Deviation
n	Total number of results for the region
α	Traffitec model result
$\bar{\alpha}$	Average of the Traffitec model result for the region

Abbreviations

LOS	Level of Service
PLOS	Pedestrian Level of Service
DPLOS	Disabled Pedestrian Level of Service
HCM	Highway Capacity Manual
AVE	Average
PHF	Peak Hour Factor
FFS	Free Flow Speed (km/h)
BFFS	Estimated Free Flow Speed (km/h)
$PTSF_d$	Percent time spent following in the analysis direction,
$BPTSF_d$	base percent time spent following in the analysis direction,

1. CHAPTER

INTRODUCTION

In the rapidly increasing city population, the number of people using vehicles and public transportation has increased, and the number of people choosing the transportation model as pedestrian transportation has also increased day by day. The effect of these increasing numbers, on Ankara vehicle and pedestrian road service levels has been investigated. The study is carried out in Ankara, the capital city of Turkey, where approximately 6 million people live for the time being. Considering the increasing numbers, it is of great importance that big cities are designed as transportation friendly. In order for the results of the study to cover Ankara in general, certain points were selected from different parts of the city. A total of 10 pedestrian and vehicle monitoring points were selected from Kızılay, Dutluk, Keçiören, Kızlar Pınarı, Demet, Kurtuluş, Pursaklar and Dikimevi regions. In order to observe time-dependent differences, a total of 3 weeks of vehicle and pedestrian counts were made between 19.07.2021 - 25.07.2021, 02.08.2021 - 08.08.2021 and 09.08.2021 - 15.08.2021. The number of vehicle and pedestrian were counted in the Ankara Metropolitan Municipality Traffic Monitoring Department by using camera screen videos. In order for the countings to be carried out in the municipality, a special permission was obtained from the Ankara Metropolitan Municipality Department of Transportation as a result of official correspondence between the university and the municipality. For the 10 selected regions, a total of 756 hours of counting was made for 3 weeks, 21 days and 12 hours in 3 different regions (Kızılay, Kızlar Pınarı, Pursaklar) in order to find effective times. Then, for the determined peak hours, a total of 441 hours were counted for 3 weeks, 21 days and 3 hours in the other 7 regions, and a total of 1197 hours were counted for 10 different regions. It is believed that successful evaluation of pedestrian walkways can promote more sustainable transportation.

It is hoped that this study conducted throughout Ankara will be a good example for further studies.

1.1. Scope of the Study

Ankara's pedestrian and vehicle roads were examined by selecting 10 different regions. Since the existing PLOS methods use different data sets and indicators and the study was conducted in the capital of a country, it was desired to use as many PLOS methods as possible. It was analyzed that 11 PLOS methods could be used with the data set we could obtain, and in this direction; The "Highway Capacity Manual (HCM)" method was applied to determine the vehicle road service level for the capital, “Highway Capacity Manual (HCM)”, “Landis”, “Mozer”, “Tan Dandan”, “Disabled PLOS”, “Sarkar”, “Trip Quality”, “Gainesville”, “Conjoint Analysis” for determining pedestrian road service levels. , “Australian” and “Traffitec” methods were applied. Since the study performed in different regions, different time intervals and different days will give a more accurate result; countings were made morning, noon and evening times between 19.07.2021 - 25.07.2021, 02.08.2021 - 08.08.2021 and 09.08.2021 - 15.08.2021. As the determination of PLOS for pedestrian walkways, crosswalks, and stairways requires different data sets and methods, the focus of this work was on evaluating PLOS values for pedestrian walkways. In line with the results obtained, firstly the methods were analyzed within themselves, then different methods were compared with each other, hours, days and weeks were compared with each other. In accordance with the results, improvement suggestions were tried to be presented where deemed necessary for the optimal result and suggestions were made for the future pedestrian road service level studies.

This thesis has the following structure: In Chapter 2, a brief literature review on sustainable pedestrian transportation, level of service concept, PLOS methodologies and their comparisons, and data gathering procedures is presented. Chapter 3 examines the dimension of PLOS assessments, eleven PLOS methodologies utilized in the evaluating pedestrian and vehicular LOS part of the thesis. Chapter 4 presents selected regions in Ankara with their measurements. In Chapter 5, results of the methods, analyzes and comparisons of methods are shared. In Chapter 6, conclusions and more recommendations regarding PLOS are presented.

2. CHAPTER

LITERATURE REVIEW

When it comes to modes of transport, the 5 most common modes that come to mind are always railways, highways, airlines, waterways and pipelines. Mode of transportation is a term used to qualify different modes of transport or ways of transporting people or goods. However, as the years passed and technology improved, walking as a mode did not even occur to people’s mind. However, walking is the most natural and simple form of movement for humans. The benefits of walking and walking as a means of transportation mode for human health and the environment are undeniable, but unfortunately it does not see the necessary importance in our country. Although one of the reasons for this is advanced and advancing technology, one of the reasons why walking is often not preferred as a mode of transportation is that the necessary conditions for pedestrians are not provided on the roads and sidewalks. Therefore, it is vital to objectively evaluate how effectively roadways accommodate pedestrian mobility. Estimating pedestrian level of service (PLOS) is the most used method for evaluating the quality of pedestrian facilities operations. Information about the methods used in this regard and their priorities are given in the literature review.

2.1. Walking as a Mode of Transportation

A critical portion of each modular trip is done on foot. In this manner, desires of pedestrians, as well as the requirements of motor vehicles, should to be taken under consideration within the plan of the urban environment and transport offices. Efforts ought to be coordinated towards secure, available and suitable versatility for people on foot. In expansion, inhabitants and guests ought to be energized to walk for sensible length outings. The appraisal of person on foot offices and strolling conditions is much more complicated than the roadway since people on foot are uncovered to an assortment of different natural conditions whereas car tenants take off in their confined environment. (Singh & Jain, 2011)

We all become pedestrians very often, and nearly every journey has some walking component. Yet despite its essential importance, walking is sometimes referred to as the neglected mode of transport. Part of the problem lies in the simplicity of walking - pedestrians can move around without relying on any technology and with almost no infrastructure - just walking on a solid surface. As such, it did not receive much attention from pedestrians, transport planners and engineers for many years. (Olszevski, 2007) The Highway capacity manual has been developed in terms of content since 1965, up to the 2010 version, and with each new edition, more and more emphasis has been placed on the pedestrian issue. Pedestrians are also an important part of transportation and therefore they are directly related to pedestrian level of service and level of service. We can define the pedestrians as, a transportation element which are transport on foot. As in small cities, in compact living areas such as campuses, walking as a mode is frequently seen, used and can be considered as the most sustainable type of transportation. For this reason, supporting and developing it as a transportation option within the campus is also of great importance in terms of level of service. In order to prevent accidents that may be directly proportional to this increase in pedestrian traffic and volume, walking as transportation should be encouraged and pedestrian safety should also be ensured. In order to ensure this safety, both pedestrian roads and highways should be examined and developed with the same meticulousness and should shed light on future designs. As pedestrian traffic increases, transportation elements such as pedestrian crossings, intersections and signalization also increase on the highway. Therefore, when designing for pedestrians, vehicle traffic should always be evaluated, pedestrian traffic should always be evaluated when designing for vehicle traffic, and these studies should be carried out taking this parallel relationship into consideration.

2.2. Walkability

Walking as a mode of transportation offers several advantages directly connected to life quality. Walking offers a link between other means of transportation that cannot be replicated. The practicable range of people's walking distances impacts the transportation system's effective service area, comfort, and utility. Walking as a form of transportation has several benefits, including regular travel times, continuous availability, common and easy-to-maintain roadways, reliable, free, non-polluting, non-energy-consuming service, and healthful, calming exercise. In urban system planning, the pedestrian mode is considered an essential building block. There is a growing interest in creating car-free zones to minimize urban pollution and restore the inner city to its previous position as a setting for interpersonal connection. Efforts are being undertaken to make walking safer, more pleasant, and more aesthetically pleasing.

Walkability is a general term for expressing the ability to travel on foot in an area. It was aimed to measure the extent to which urban design is suitable to accommodate pedestrians rather than cars. Many places have begun to promote walkability concepts in recent years by informing the public of the advantages of walking and influencing local governments to improve non-motorized transportation facilities. Second, it necessitated the measurement of pedestrian facility performance in order to establish operational quality, present weaknesses, upgrade needs, and priority areas. When measuring walkability, overall grade of pedestrian amenities, road conditions, area usage forms, community engagement, safety, and walking satisfaction should all be evaluated.

Bradshaw (1993) introduced four desirable traits to define ideal walkability. These factors are as follows:

- Pedestrian friendly: wide walkways, few intersections and only narrow streets to cross, good lighting and no obstructions;
- Attractivity: stores, services, jobs, professional offices, recreational opportunities, libraries, etc.
- Environmental systems: no extreme noise, poor air quality, filth, stains and vehicular traffic emissions.
- Social interaction: conditions for easy communication and improved social interaction between people.

Pedestrian comfort factors can be determined as an emotional reaction to a variety of different environmental factors. In other words, under this approach, pedestrians are free to use their own space, allowing them to carry out their activities in an open manner. Physical, mental, and physiological comfort are the three types of pedestrian comfort. Physical consolation implies the least exertion required for pedestrian development. Physical consolation depends on satisfactory walking way, persistent asphalt, nonappearance of impediments, comfortable walking surface, sitting place and assurance from extraordinary climate conditions. Mental comfort is achieved when the pedestrian has the capacity to preserve the required walking pace and take an interest in different pedestrian activities. Discuss contamination level and noise pollution characterize the physiological condition of pedestrians. (Sarkar, 2002)

2.3. Level of Service (LOS)

Level of service (LOS) is a simple grade system for describing complex numerical performance or research results, and the quality of the service provided by the facility. The grade Level of service removes much of the complexity to simplify the decision as to whether the performance of the place used for transportation is generally acceptable and whether a change in that performance is perceived as significant by the general public. Level of service is a quantitative stratification of service quality into a six grade with the grade "A" representing the "best" service quality and the grade "F" representing the "worst" service quality.

This system has been accepted all over the world and has been used all over the world since its inception. Although it is necessary to use a separate level of service for each transport mode, most of the work in this area has been done on vehicle traffic. Although issues such as bicycle, transit, vehicle traffic, pedestrian service level have been jointly addressed and multi-modal level of service studies have been carried out with increasing studies in recent years, vehicular LOS is still the most known and used system today. Level of service ranges for multi-lane highways can be seen in Table 2.1.

In order to represent the quality of the service provided on a road, the concept of level of service is used as a quality metric when describing the operating circumstances in the traffic flow. Many factors influence the amount of service provided by a road. For urban roads, we can list these factors as follows: road width, number of lanes, distance between intersections on the road, speed of vehicles, geometry of the road, amount of commercial vehicles, speed of vehicles that make up the traffic, parking facilities, near stops, type of sidewalk, slope of the road, etc.

The hourly maximum value of cars or pedestrians that can be expected to travel through a place or part of the road or lane under current traffic, control, and road conditions is known as the road capacity (HCM, 2000).

Table 2.1. Level of service ranges for multi-lane highways

Level of Service						
(veh/km/lane)	A	B	C	D	E	F
Density (HCM 2000)	0-7	7-11	11-26	16-22	22-28	>28
Density (HCM 2010)	0-11	11-18	18-26	26-35	35-45	>45

In this study, although some method uses require the use of vehicular level of service, the study will mostly focus on pedestrian level of service.

2.3.1. Pedestrian Level of Service (PLOS)

Due to the multifaceted nature of the pedestrian environment, the roadside pedestrian is exposed to a range of elements that impact their perceptions of safety, comfort, and convenience. Measuring these variables is fundamental for surveying pedestrian amenities, and determination strategies are required to get it how well a specific road reacts to pedestrian travel. There is a need for methodologies that allow organizers and decision-makers to effectively discern and analyze the components of the structured environment that encourages or discourage walking in order to properly build more walkable circumstances. For many years, the quality of the pedestrian environment has been assessed using a Level of Service (LOS) approach. Numerous factors determine LOS for pedestrian facilities, and various pedestrians have varying perceptions of LOS. Pedestrian LOS could be a common degree of walking conditions on a course, street or facility. The LOS of a motor vehicle is primarily determined by speed, travel time, and junction delay. The pedestrian LOS evaluation is more complicated, and it represents the state of the pedestrian facility as well as the level of comfort that pedestrians experience when using it. Pedestrian LOS is a common degree of walking conditions on a course, street or office. This can be straightforwardly connected to components influencing versatility, comfort and security and reflects pedestrians' perceptions of the facility's degree of "pedestrian friendly". The existing techniques to provide pedestrian amenities and methodologies for determining the level of service (LOS) for pedestrians are discussed in this study. The strengths and shortcomings of pedestrian facilities are assessed, and recommendations are given to obtain a more satisfactory service level analysis. Traffic designers and coordinators can think of an acceptable methodology for assessing the level of service for walking by comprehending and going beyond present LOS methodologies.

2.3.2. Determining PLOS

Unfortunately, today's PLOS studies still do not see as much value as the vehicle LOS, as we have mentioned before. As the most general example of this situation in our country, it can be shown that even when the subject of level of service is covered in the lessons, the vehicle level of service is mostly covered and the pedestrian service level is not mentioned in most of the textbooks. For this reason, although there are much less PLOS studies and methods compared to vehicle LOS, there are still enough PLOS methods in the literature to make this assessment. It is a fact that, as we have mentioned in recent years, importance has started to be given to the transportation systems that increase the mobility quality of pedestrians. Pedestrians are becoming the center of urban mobility, and assessment of the level of pedestrian service becomes the main target of recent research on urban transport, while past research focuses on car movements. Accordingly, it is critical to assess the level of pedestrian service to improve existing infrastructure, as it is associated with factors affecting pedestrian mobility, safety and comfort. PLOS working and methods are nowadays generally divided into two when multi-modal methods are excluded; Crosswalk pedestrian service levels and sidewalk pedestrian service levels between two intersections. This study will focus more on the sidewalk pedestrian service levels. While there are multiple factors in determining the sidewalk service level, the pedestrian perspective should definitely be taken into account when assessing the service level, such as walkway width, sidewalk type, etc. In this case, when the pedestrian perspective is included, many other factors are involved that can affect the level of service.

Fruin (1971) developed the basic PLOS strategy, which was focused on sidewalk capacity and volume. Tanaboriboon and Guyano (1989) advocated using LOS calculation to plan Bangkok walkways based on zone occupancy per person. As a guide, they used Fruin's LOS plan standard. PLOS was also evaluated by the Transport Research Board (2000), which took into account volume, capacity, and speed. The US Highway Capacity Manual (Mateo-Babiano and Ieda 2007) is used to build most pedestrian facilities in developing

Asian countries. Many analysts have challenged the HCM technique since pedestrians are classified as vehicles in this paradigm.

Highway Capacity Manuel, which is used and accepted all over the world, is the first resource to be reached in this field. Considering the HCM method, although various factors such as sidewalk width, clustering etc. are used, it is basically linked to the speed-density-flow relationship. When evaluating PLOS with the HCM method, our criteria used are basically: square meters per pedestrian, pedestrian flow rate, pedestrian speed, and volume / capacity ratio. These values are proportionally or inversely related to each other. For example, when volume and density decreases, the pedestrian speed increases. As the density of people increases, the area per person decreases, so the walkability and the average speed of pedestrians will decrease.

In this context, the HCM method's pedestrian level of service approach is very similar to the vehicle level of service approach. In PLOS studies, many methods such as the Conjoint Analysis method have emerged by suggesting that the HCM method is inadequate and it is a wrong approach to consider pedestrians as vehicles.

Sarkar (2002), adopting the idea of "safety, security, efficiency, consistency, comfort, system coherence, and attractiveness are the key goals of pedestrian improvement schemes." stated by Fruin (1971); It has created an evaluation method that is done in two different ways. First one; At the macro level, service levels establish norms for commonly acceptable and unwanted comfort conditions. The second is Quality Levels, which examine the finer points of improving pedestrian comfort on a micro level. For these details, he evaluated four comfort factors and 6 stages. These comfort factors; Protection against adverse weather conditions, excessive noise, and poor air quality levels are all factors that must be considered while providing resting spots and additional sitting.

Jaskiewicz (1999) says “Traveling from point A to point B is only part of the pedestrian experience”; He proposed nine important measures and listed them as Enclosure / definition, diversity of road system, structural articulation, area diversity, transparency, buffering, tress, sloped ceilings / canopies / various roof types, and physical components / condition.. It has created a scoring system from 1 to 5 for each and created a system where it will determine the level of service according to this scoring.

Another scoring system using different segments was found by Dixon (1996) as the Gainesville Method. Gainesville pedestrian LOS key performance indicators assess highway corridors from A to F using a score scale ranging from 1 to 21.

In a study conducted in China, Tan D. (2007) found that the kind of road intersection, pedestrian flow characteristics, vehicular and bicycle flow features, impediments, and the frequency of access to the roadway are all elements that affect service level. The relationship between pedestrians' arbitrary decisions and also the quality of route physical amenities was examined in order to assess LOS with these criteria. As a result of the analysis, he produced a formula and made the LOS evaluation according to his own table.

Muraleetharan (2004), who made his study in Japan, found the method called Conjoint Analysis. By incorporating several characteristics that affect pedestrian traffic, Conjoint Analysis finds the pedestrian LOS for walkways and crosswalks. The most important feature of this method is that it has a "value system". Conjoint analysis predicts the "value system" that determines how much an individual puts at each level of attributes. That is, attributes are weighted according to how important a user considers them.
The Landis Method assesses sidewalk operating quality by considering a pedestrian's perception of comfort and safety. Landis (2001) revealed his own formulated method with a complex evaluation by analyzing with six factors he determined. This method is a good approach to objectively quantify pedestrians' perceptions of roadway safety and comfort. The ability of roads to adapt to pedestrian travel can be quantified.

Jensen Soren Underlien (2007) had used cumulative logit regression of pedestrian ratings and variables associated to satisfaction ratings to establish a pedestrian satisfaction model. Not very satisfied, moderately unsatisfied, somewhat unhappy, somewhat satisfied, moderately satisfied, moderately satisfied, and extremely satisfied were the grades given to highway segments. The model takes into account factors including pathway style, roadside development, and landscape type, among others.

To facilitate LOS measurement, Nicolle Gallin (2001) created a novel model based on numerous parameters impacting pedestrian LOS. There are three categories for these factors: physical qualities, location factors, and user factors. Based on the relative relevance of these parameters, a LOS scale was constructed to characterize the LOS of the pedestrian pathways. On the basis of on an evaluation of indicators impacting LOS, pedestrian elements are classified as LOS A (excellent pedestrian conditions) to LOS E (unfavorable pedestrian conditions). This method, which has been developed in a simple but useful way using ten variables in total, is called the Gallin or Australian Method.

The Time-Space Concept was a new method introduced by Gregory Benz in 1986 for analyzing LOS. Within the time-space framework, pedestrian activities generate time-space requirements. The regions in which these activities occur are time-space zones. They have limited capacity to accommodate the time-space needs of pedestrians. At the same time, he shaped his method with a mathematical formula.

Mozer (1997) created its own method by examining pedestrians, bicycles, vehicles and transits separately and formulating their level of services under the name of multi-modal level of service. Based on 4 main factors for pedestrians, Mozer (1997) evaluated and scored each factor according to the stress level. He rated his result from A to E under the name of level of service.

Although Dowling (2008) looks at many level of services under the name of multi-modal, he made an evaluation in four steps by reducing this situation to two types for pedestrians. One of these two types is made by using density according to HCM and the other is made by analyzing it in a formulaized way without using it. The stages are divided into four: first to split the road into parts, to find a level of service according to HCM, to find a level of service without using HCM, and to use whichever one is lower.

Although so many methods have been developed for PLOS to date, most of the almost accepted methods do not take into account pedestrians with disabilities. The goal of all contemporary PLOS models is to measure pedestrian safety and comfort. The most unexpected aspect of the literature analyzing walking conditions, however, is the absence of studies that identify impaired pedestrians as significant street users with distinct requirements needing appropriate amenities. Moeinaddini et al (2013) recognized this problem and included disabled pedestrians in the equation and formulated a disabled PLOS method with the indicators they considered.

Today, there are other pedestrian level of service studies. As an example of this, Frackelton (2013) made a different evaluation system using modern technologies with researchers at Georgia Institute of Technology. Using wheelchairs, they turned it into a research tool. Gyroscope tablet, accelerometer, video camera, GPS transceiver were attached to the wheelchair. They drove the wheelchair to many points in their research area using manpower. This evaluation was conducted to collect information on the sidewalk's width, surface quality, the existence of curb ramps, and the presence of obstructions. Khisty devised a quantitative approach for calculating pedestrian LOS using nearly the same criteria as Sarkar (Khisty.C.J, 1994). Despite the fact that Khisty's technique gave a quantifiable measurement of pedestrian LOS on a score rating, the findings of this grading were difficult to comprehend. Miller (Miller et al., 2000) further presented a scale-based approach for assessing pedestrian LOS. Alternatives to improve the existing conditions were offered, and the proposed model was calibrated utilizing 3D representation.

Sidewalks are a critical part of sustainable transport systems. Quality pedestrian infrastructure supports walking as a suitable mode choice and promotes healthy physical activity. It has been shown that the existence and quality of sidewalks are significant markers of perceived safety and overall happiness in the pedestrian environment. (Landis et al, 2005). Without infrastructure for pedestrians, the urban traffic system cannot exist. When developing new roads or planning the repair of existing highways, the demands of pedestrians should be taken into account. Unfortunately, in many Turkish cities, there are several issues with sidewalks and other parts of pedestrian infrastructure, necessitating evaluation and, if required, restructuring. We must move beyond tightly defined LOS ideas and establish evaluation techniques that take into consideration the breadth of walking experiences. Methods of evaluation should not be directed by statistics that can be readily measured and manipulated, but should incorporate pedestrian and planner walking experience.

2.4. Data Collection Techniques

For vehicle traffic, it is crucial to understand the quantity of necessary or gathered traffic data. Manual counts and automated counts are the two primary kinds of traffic counting. However, there is no discernible difference between the two approaches; the economical usage or selection of an appropriate traffic counting method depends on the traffic flow level and the desired data quality.

The most prevalent way for collecting data on traffic flow is the manual approach, which entails assigning a person or group to record passing vehicles. This form of data gathering can be labor-intensive, but it is necessary in the majority of situations when cars will be categorised based on a succession of independently recorded movements, such as at junctions. In intersection areas, the traffic on each lane should be tallied and recorded independently for each movement. On highways with several lanes, it is crucial to count and classify traffic according to the direction of flow.

Typically, permanent traffic count teams are established at various points along the road network to conduct the count at predetermined intervals. The duration of the count is decided by the intended use of the data before the traffic count begins. Teams are directed and monitored by technical personnel to guarantee efficient and accurate data collection. Historically, vehicle presence and road occupancy determinations were conducted largely on or near the road surface. The employment of electromagnetic spectrum and wireless communication medium has enabled non-intrusive traffic detection upstream or next to the road. In the next years, sidewalk-based traffic detection, which is now relatively inexpensive, will encounter severe competition from road-based detectors.

Intelligent transportation systems have a growing importance and to improve it, there is a serious need for data accumulation. To collect real-time traffic data, on road sensors which are used traditionally is not enough because of their cost of maintenance and implementation and also they have restricted scope of gathering data (G. Leduc, 2008). For this reason, the search for different data sources, which will provide more comprehensive data, are less costly and more effective, results in the acquisition of new data resources day by day. Technologies that can obtain traffic data with detectors placed outdoors and on the roadside can be summarized as in-situ technologies. These technologies are very important resources for obtaining real-time traffic data. Pneumatic road tubes, piezoelectric sensors, magnetic loops can be defined as the most conventional Technologies which are used in-situ data collection. Also, manual counts, passive and active infra-red, passive magnetic sensors, microwave radar, ultrasonic and passive acoustic and video image detection are other methods which are used. They have a capability to sense a variety of data. All of them can present the data of volume and count, most of them can also present the data of classification, speed, occupancy, and presence. Ultrasonic method is the less efficient method among all because it can only present the data of volume and presence.

2.4.1. PLOS Data Collection Techniques

In the data to be obtained for the PLOS study, the precision of the data is very important. Although there are various measurement methods for flow-speed-density, the pedestrian perspective is very important for the use of the methods. In such cases, questionnaires and the analyst's own comments are often used. The data to be taken will be used in the study to be done.

Common methods used to collect data for the pedestrian level of service are:

- Questionnaire
- Analyst's assessment
- hand counting,
- time-lapse photography technique,
- recording with a video camera,
- counting by press button.

In San Francisco, California, the accuracy of the three counting techniques outlined by Diogenes et al (2007) was determined by doing simultaneous counts at 10 separate crossings; the findings revealed that both manual counting and clickers underestimated the number of people present.

In most research, video recording is employed to collect pedestrian data (Al-Azzawi1 & Raeside, 2007). However, in certain studies, survey questionnaires are used to examine the attitudes and psychological behaviors of pedestrians.

The data that intelligent transportation systems can provide could be very efficient as it can be simultaneous and high quality, but today these systems mostly meet the data needs for vehicular transportation. However there is an obvious requirement for walkability and pedestrian statistics, it is difficult to apply vehicle counting technology directly due to the highly variable nature of pedestrian flow in comparison to vehicle traffic. This makes data collecting and geolocation more challenging. On the market are a variety of automatic pedestrian counting devices and systems, including passive infrared sensors and piezoelectric pads, infrared ray counts, laser scanners, and computer vision systems.

There are many factors that are effective when determining the pedestrian level of service. These factors are mostly environmental factors. The type of use of the environment directly affects pedestrian density, age and gender distribution, walking distance, walking time, pedestrian traffic and pedestrian behavior. There is a high pedestrian density in the campus. The fact that the distances walked within the campus are so short that they do not require the use of vehicles, the fact that the age distribution of the pedestrians in a university campus, where is the young age is predominant, required the pedestrian level of service design to be considered seriously. Factors including comfort and safety factors such as weather conditions, topography and network density should also be addressed within the pedestrian level of service.

2.5. Improvement of Road Standards, Safety and Efficiency

As modern traffic and transportation develop day by day, there is a need to increase safety in direct proportion with the sustainability of transportation. The fact that the transportation area that should serve humanity, results in many deaths, is a result of inadequate engineering design rather than user errors which are passengers and pedestrians. Transportation data analysis has a very important role at this point.

To improve LOS and PLOS, many factors must be considered. The importance of data collection techniques, the way of using this data, environmental factors, rise in the need for capacity increase, determination of ideal conditions are of great importance for the beginning of the design of the road. Ideal road conditions must be as: presence of at least two road lanes in each direction, vehicles which are moving close to each other, traffic flow consists of automobiles only (no heavy vehicles), sufficient strip width, shoulder width and side openings, lack of obstacles to interfere with traffic flow due to factors such as traffic control. A design should be started by considering the direct relationship of PLOS and LOS.

Level of service shows different competencies within days. For the same route, level of service differs greatly on weekdays and weekends, especially in an environment that includes schools, workplaces and hospitals. For this reason, the daily demands and needs and the traffic volume had to be taken into account in improving the level of service.

3. CHAPTER

EVALUATING PEDESTRIAN AND VEHICULAR LOS

In this chapter, pedestrian and vehicular level of service of sidewalks and roads were studied in two different parts. For pedestrian level of service (PLOS) behavior 11 different methods were conducted to obserse various methods effects on LOS and comparison to find the suitable technique. Additionally, roads of 10 varios places were studied by using one method, which is Highway Capacity Manual (2010) method (HCM).

3.1. Vehicular LOS Methods Used in This Study

Transportation Research Board's (2010) Highway Capacity Manual (HCM) is a compilation of the state of the art in approaches for assessing traffic operating performance and capacity utilization (congestion level) for a range of transportation assets. One of the pillars of the HCM is the notion of service level (LOS). Level of service is a qualitative evaluation of the traffic operating conditions faced by facility users under specified highway, traffic, and traffic control (if present) conditions. The current standard specifies six service levels, ranging from A to F, with A representing the best operating conditions and F the worst.

Any transportation facility is capable of measuring and calculating a number of operational performance metrics, such as speed, flow, and density. To apply the level-of-service idea to traffic studies, it is required to choose a performance metric that reflects how motorists evaluate the quality of service they were receiving on a facility. Motorists typically rate the quality of service they have gotten based on characteristics such as speed and travel time, maneuverability, traffic disruptions, and comfort and convenience. Consequently, it is essential to pick a metric that incorporates some or all of these characteristics. Service measure refers to the performance metric adopted for level-of-service (LOS) examination of a certain transportation facility.

3.1.1. Multilane Highway LOS

Multilane highways are comparable to freeways in most aspects, with the exception of a few significant distinctions:

- At at-grade crossings and driveways, vehicles may enter or exit the road.
- Freeways are always split, whereas multilane roads may or may not be (by a barrier or median dividing opposing directions of movement).
- There may be traffic lights present.
- Sometimes, design criteria (such design speeds) are lower than those for highways.

The technique for determining the level of service on multilane roads closely resembles that of freeways. The primary distinctions lay in the adjustment factors and their respective values. The main values required to determine LOS are Free Flow Speed, Flow Rate and Density and the realationship of these values are shown in Figure 3.1 with the LOS grades.

$$q = uk \tag{3.1}$$

Where

q = Flow as veh/h

u = Speed as km/h

k = Density as veh/km

$$FFS = BFFS - f_{LW} - f_{LC} - f_M - f_A \tag{3.2}$$

Where

FFS = estimated free-flow speed in kilometers per hour,

$BFFS$ = estimated free-flow speed, in km/h, for base conditions,

f_{LW} = adjustment for lane width

f_{LC} = adjustment for lateral clearance

f_M = adjustment for median type

f_A = adjustment for the number of access points along the roadway

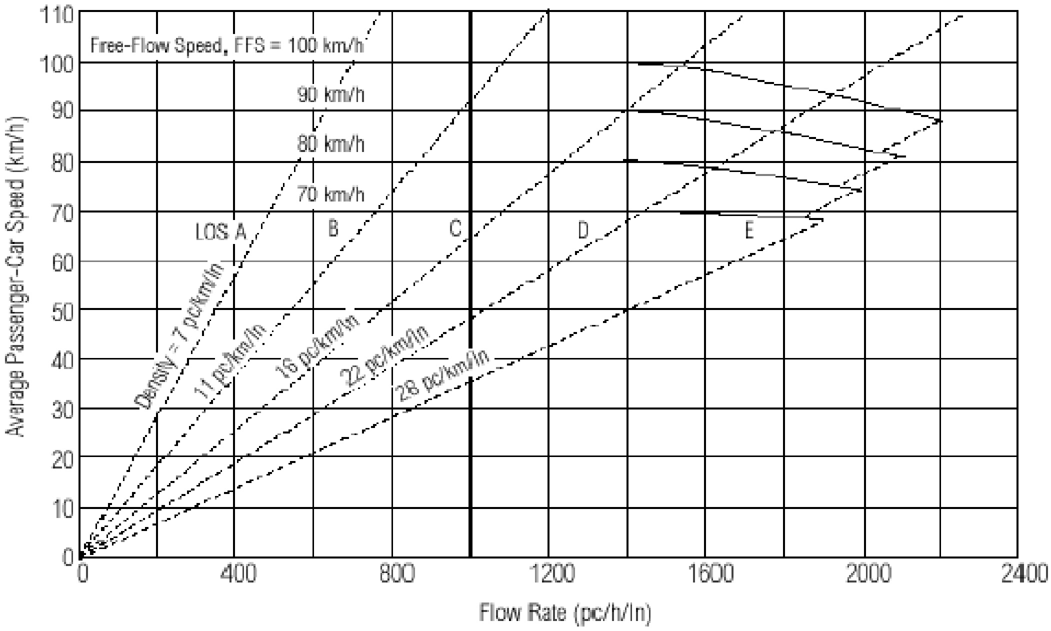

Figure 3.1. Criteria for Multilane Highway Speed-Flow Curves and LOS

According to the Highway Capacity Manual, the BFFS value is found by adding 8 km/h to posted speed value when the posted speed is 80 km/h and above. And, for the cases posted speed value is below 80 km/h, BFFS valuse is found by adding 11 km/h to the posted speed value.

Lane width adjustment factor is calculated by the lane width itself only. Since the lane width should not be less than 3.00 for Multilane Highways, these values are given in the Table 3.1 by specifying between 3.00 and 3.60 meters.

Table 3.1. Lane Width Adjustment Factor Table

Lane Width (m)	f_{LW}
3.60	0.00
3.30	3.10
3.00	10.60

Before determining the correction factor for lateral clearance, total lateral clearance is computed.

$$TLC = LC_R + LC_L \tag{3.3}$$

Where

TLC = lateral clearance in meters,

LC_R = lateral clearance on right,

LC_L = lateral clearance on left.

After applying the Equation 3.3 the lateral clearance adjustment factor value is taken from the Table 3.26.

Table 3.2. Lateral Clearance Adjustment Factor Table

TLC	f_{LC}	
	4-Lane Highway	6-Lane Highway
3.6	0	0
3	0.6	0.6
2.4	1.5	1.5
1.8	2.1	2.1
1.2	3	2.7
0.6	5.8	4.5
0	8.7	6.3

To determine median and access frequency adjustment factors, after necessary information is gathered about the roadway, Table 3.3 and Table 3.4 are used respectively.

Table 3.3. Table Median Adjustment Factor Table

Median type	f_M
Undivided	2.6
Divided	0.0

Table 3.4. Access Point Adjustment Factor Table

Access Points/km	f_A
0	0
6	4
12	8
18	12
24	16

After the free flow speed is found, then the flow rate should be found. Since the number of vehicles passing by at certain hours may be higher than at other hours, the peak hour factor is distributed in the formula while calculating the flow rate, and the calculation is made in accordance with the 15-minute period. Apart from this, since heavy vehicles using the route affect the traffic, there is also a heavy vehicle adjustment factor in the formulation.

$$v_p = \frac{V}{PHF\ x\ N\ x\ f_{HV}\ x\ f_p} \tag{3.4}$$

Where

v_p = 15-min passanger car equivalent flow rate (pc/h/ln)

V = hourly volume for hour of analysis (veh/h)

PHF = peak hour factor

N = number of lanes

f_{HV} = Heavy-vehicle modification factor

f_p = driver population factor

$$PHF = \frac{V}{V_{15}\ x\ 4} \tag{3.5}$$

Where

V_{15} = maximum 15-min volume within the hour of analysis

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)} \quad (3.6)$$

Where

P_T = Percentage of trucks

P_R = Percentage of RVs

E_T = Passenger car equivalent for trucks from Table 3.5. or Table 3.6.

E_R = Passenger car equivalent for RVs from Table 3.7.

Table 3.5. Truck Passenger Car Equivalent for Downgrade

Downgrade (%)	**Length (km)**	**Percentage of Trucks and Buses**			
		5.0	**10.0**	**15.0**	**20.0**
< **4**	**All**	1.5	1.5	1.5	1.5
4 - 5	**≤ 6.4**	1.5	1.5	1.5	1.5
4 - 5	> **6.4**	2.0	2.0	2.0	1.5
> **5 - 6**	**≤ 6.4**	1.5	1.5	1.5	1.5
> **5 - 6**	> **6.4**	5.5	4.0	4.0	3.0
> **6**	**≤ 6.4**	1.5	1.5	1.5	1.5
> **6**	> **6.4**	7.5	6.0	5.5	4.5

Table 3.6. Truck Passenger Car Equivalent for Upgrade

Upgrade (%)	**Length (km)**	**Percentage of Trucks and Buses**									
		2	**3**	**4**	**5**	**6**	**8**	**10**	**15**	**20**	**25**
< **2**	**All**	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
≥ 2 - 3	**0.0 - 0.4**	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> **0.4 - 0.8**	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> **0.8 - 1.2**	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> **1.2 - 1.6**	2.0	2.0	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5

	> 1.6 - 2.4	2.5	2.5	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.0
	> 2.4	3.0	3.0	3.0	2.5	2.5	2.0	2.0	2.0	2.0	2.0
> 3 - 4	**0.0 - 0.4**	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 0.4 - 0.8	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.5	1.5	1.5
	> 0.8 - 1.2	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	> 1.2 - 1.6	3.0	3.0	3.0	2.5	2.5	2.5	2.5	2.0	2.0	2.0
	> 1.6 - 2.4	3.5	3.5	3.5	3.0	3.0	3.0	3.0	2.5	2.5	2.5
	> 2.4	4.0	3.8	3.5	3.0	3.0	3.0	3.0	2.5	2.5	2.5
> 4 - 5	**0.0 - 0.4**	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 0.4 - 0.8	3.0	2.8	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.0
	> 0.8 - 1.2	3.5	3.3	3.0	3.0	3.0	2.5	2.5	2.5	2.5	2.5
	> 1.2 - 1.6	4.0	3.8	3.5	3.5	3.5	3.0	3.0	3.0	3.0	3.0
	> 1.6	5.0	4.5	4.0	4.0	4.0	3.5	3.5	3.0	3.0	3.0
> 5 - 6	**0.0 - 0.4**	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	> 0.4 - 0.8	4.0	3.5	3.0	2.5	2.5	2.0	2.0	2.0	2.0	2.0
	> 0.8 - 1.2	5.0	4.8	4.5	4.0	3.5	3.0	3.0	3.0	3.0	3.0
	> 1.2 - 1.6	5.5	5.3	5.0	4.5	4.0	3.0	3.0	3.0	3.0	3.0
	> 1.6	6.0	5.5	5.0	5.0	4.5	3.5	3.5	3.5	3.5	3.5
> 6	**0.0 - 0.4**	4.0	3.5	3.0	2.5	2.5	2.5	2.5	2.0	2.0	2.0
	> 0.4 - 0.8	4.5	4.3	4.0	3.5	3.5	3.5	3.0	2.5	2.5	2.5
	> 0.8 - 1.2	5.0	4.8	4.5	4.0	4.0	3.5	3.0	2.5	2.5	2.5
	> 1.2 - 1.6	6.0	5.8	5.5	5.0	5.0	4.5	4.0	3.5	3.5	3.5
	> 1.6	7.0	6.5	6.0	5.5	5.5	5.0	4.5	4.0	4.0	4.0

Table 3.7. Passenger Car Equivalent for RVs

Upgrade (%)	**Length (km)**	**Percentage of RVs**									
		2	**3**	**4**	**5**	**6**	**8**	**10**	**15**	**20**	**25**
≤ 2	**All**	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
> 2 - 3	**0.0 - 0.8**	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
	> 0.8	3.0	2.3	1.5	1.5	1.5	1.5	1.5	1.2	1.2	1.2
> 3 - 4	**0.0 - 0.4**	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
	> 0.4 - 0.8	2.5	2.5	2.5	2.0	2.0	2.0	2.0	1.5	1.5	1.5

	> **0.8**	3.0	2.8	2.5	2.5	2.5	2.0	2.0	2.0	1.5	1.5
4 - 5	**0.0 - 0.4**	2.5	2.3	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5
	> **0.4 - 0.8**	4.0	3.5	3.0	3.0	3.0	2.5	2.5	2.0	2.0	2.0
	> **0.8**	4.5	4.0	3.5	3.0	3.0	3.0	2.5	2.5	2.0	2.0
> **5**	**0.0 - 0.4**	4.0	3.5	3.0	2.5	2.5	2.5	2.0	2.0	2.0	1.5
	> **0.4 - 0.8**	6.0	5.0	4.0	4.0	3.5	3.0	3.0	2.5	2.5	2.0
	> **0.8**	6.0	5.3	4.5	4.0	4.5	3.5	3.0	3.0	2.0	2.0

3.1.2. Two-lane Highway LOS

The definition of a two-lane highway is a road having one lane in each direction and the traffic in the other way has a significant impact on service quality. A high number of opposing traffic, for instance, restricts the ability to pass slow-moving cars and, as a result, necessitates a slower traffic pace and a poorer quality of service. Consequently, any physical characteristics that limit passing sight distance will have a negative effect on the quality of service. Lastly, the type of plays a greater role in level-of-service calculations than freeways and multilane highways due to the limited ability to pass slower-moving vehicles on grades in areas where passing is prohibited due to sight distance restrictions or opposing traffic does not permit safe passing.

The analysis procedure for two-lane highways in the Highway Capacity Manual (Transportation Research Board 2010) provides performance measure values and levels of service that are specific to only one direction of travel.

Three service metrics for two-lane highways have been identified:

- percent time spent following,
- average travel speed,
- percent of free-flow speed.

PTSF is the average percentage of time spent traveling behind slower vehicles due to a lack of passing opportunities. It is difficult to evaluate PTSF in the field; thus, it is proposed that the fraction of vehicles moving at fewer than 3-second headways at a typical location be used as a proxy. PTSF often reflects the mobility of a motorist inside the traffic flow. The average travel speed (ATS) is determined by dividing the segment's length by the average travel time of all vehicles traversing the segment during the analysis period. ATS indicates mobility on a two-lane motorway. The percent free-free flow speed (PFFS) is calculated by dividing the segment's average travel speed by its free-flow speed. PFFS is a measurement of how close vehicles may come to their desired speed.

According to the HCM (2010), two-lane highways are separated into three different classes. In this study only one region is a two-lane highway and it is classified as Class II. On Class II two-lane roadways, drivers do not always anticipate traveling at high speeds. Class II is frequently awarded to shorter roads and routes that traverse harsh terrain, where travel speeds are typically slower than on Class I roadways. In these scenarios, drivers should avoid lengthy following distances behind other cars.

$$FFS = BFFS - f_{Lw} - f_A \tag{3.7}$$

Where

FFS = estimated free-flow speed in kilometers per hour

$BFFS$ = estimated free-flow speed, in km/h, for base conditions

f_{LW} = adjustment for lane and shoulder width from Table 3.8.

f_A = adjustment for the number of access points along the roadway

Table 3.8. Lane and Shoulder Width Adjustment Factor

Lane Width	f_{LW}			
	≥ 0.0 < 0.6	≥0.6<1.2	≥1.2<1.8	≥1.8
2.7<3	10.3	7.7	5.6	3.5
≥3<3.3	8.5	5.9	3.8	1.7
≥3.3<3.6	7.5	4.9	2.8	0.7
≥3.6	6.8	4.2	2.1	0

$$v_i = \frac{V_i}{PHF\ x\ f_{HV}\ x\ f_G}$$

(3.8)

Where

v_i = 15-min passanger car equivalent flow rate for direction i (pc/h/ln)

V_i = hourly volume for direction i (veh/h)

PHF = peak hour factor

f_G = grade adjustments factor

f_{HV} = Heavy-vehicle modification factor

Since two-lane highways determined as Class II evaluate LOS only on Percent Time Spent Following (PTSF), tables related to PTSF are shown in this study. Grade adjustment factors for PTSF are shown in Table 3.9 with the directional flow rate intervals. And, Passanger car equivalents for heavy vehicles are shown in Table 3.10.

Table 3.9. Grade Adjustment Factor for Percent Time Spent Following

PTSF		
Directional Flow Rate	Level terrain	Rolling Terrain
≤ 100	1	0.73
200	1	0.8
300	1	0.85
400	1	0.9
500	1	0.96
600	1	0.97
700	1	0.99
800	1	1
≥ 900	1	1

Table 3.10. Passenger Car Equivalent for Trucks and RVs

PTSF			
Vehicle Type	Flow Rate (veh/h)	Level Terrain	Rolling Terrain
Et	100	1.1	1.9
	200	1.1	1.8
	300	1.1	1.7
	400	1.1	1.6
	500	1.0	1.4
	600	1.0	1.2
	700	1.0	1.0
	800	1.0	1.0
	900	1.0	1.0
Er	All flows	1.0	1.0

$$PTSF_d = BPTSF_d + f_{np}(\frac{v_d}{v_d + v_o})$$

(3.9)

$PTSF_d$ = Percent time spent following in the analysis direction,

$BPTSF_d$ = base percent time spent following in the analysis direction,

f_{np} = adjustment factor for no passing zones from Table 3.11.

Table 3.11. No Passing Zone Adjustment table for PTSF

vd+vo	No Passing Zone (%)					
(pc/h)	0	20	40	60	80	100
Directional Split = 50/50						
≤ 200	9	29.2	43.4	49.4	51	52.6
400	16.2	41	54.2	61.6	63.8	65.8
600	15.8	38.2	47.8	53.2	55.2	56.8
800	15.8	33.8	40.4	44	44.8	46.6
1400	12.8	20	23.8	26.2	27.4	28.6
2000	10	13.6	15.8	17.4	18.2	18.8
2600	5.5	7.7	8.7	9.5	10.1	10.3

≥ 3200	3.3	4.7	5.1	5.5	5.7	6.1

$$BPTSF_d = 100[1 - \exp(av_d^b)] \quad (3.10)$$

Where a and b are constants determined from Table 3.12.

Table 3.12. PTSF Coefficients for Formula 3.10

Opposing Flow Rate, vo (pc/h)	Coefficient a	Coefficient b
≤ 200	-0.0014	0.973
400	-0.0022	0.923
600	-0.0033	0.87
800	-0.0045	0.833
1000	-0.0049	0.829
1200	-0.0054	0.825
1400	-0.0058	0.821
> 1600	-0.0062	0.817

Class II Two-Lane Highway LOS grades for are shown in the Table 3.13.

Table 3.13. LOS Grades for Two-Lane Highways

Class II	
LOS	Percent time spent following (PTSF)
A	≤ 40
B	≤ 55
C	≤ 70
D	≤ 85
E	>85

Note: LOS F applies whenever demand flow rate axceeds the segment capacity.

3.2. PLOS Methods Used in This Study

3.2.1. Highway Capacity Manual Pedestrian LOS Method

Capacity and quality of sidewalks were studied and Highway Capacity Manual (2010) was applied. In determining the LOS, HCM divided the PLOS into two sections; Uninterrupted-Flow pedestrian amenities i.e. walkways and sidewalks, queuing areas and Interrupted-Flow pedestrian amenities i.e. intersections. Using the flow-density-speed relationship as the basic logic for both sections, HCM also divided the walkways and sidewalk section in three parts, under the names of walkways, cross flows and stairs. Only the walkway part is used in this study for all regions.

As indicated in Table 3.14, the computation of pedestrians per minute per meter (ped / min / m) serves as the foundation for the grading of the pedestrian level of service. When PLOS A is present on a sidewalk or walkway, pedestrians can move freely without changing their pace in response to other pedestrians or a restriction in the width of the pavement. On the other hand, on a sidewalk or route with PLOS F, all walking speeds are highly restricted, and forward moving is quite difficult. Calculate the pedestrian unit flow rate (ped / min / m) by dividing the 15-minute pedestrian flow rate by the effective route width. HCM recommends collecting pedestrian counter-flow volumes at 15-minute intervals in order to calculate the pedestrian flow rate. The 15-minute flow rate is the sum of the flow in both directions. Subtracting the obstacle widths and the buffer width of 0.3 to 0.5 m per obstacle from the overall width of the path yields the effective width of the sidewalk used in the calculation. The widths of obstacles may be measured on the field.

Table 3.14. Criteria for Average Flow PLOS on Walkways HCM (2010)

LOS	Space (m2/p)	Flow Rate (p/min/m)	Speed (m/s)	v/c Ratio
A	> 5.6	≤ 16	> 1.30	≤ 0.21
B	> 3.7 - 5.6	> 16 - 23	> 1.27 - 1.30	> 0.21 - 0.31
C	> 2.2 - 3.7	> 23 - 33	> 1.22 - 1.27	> 0.31 - 0.44
D	> 1.4 - 2.2	> 33 - 49	> 1.14 - 1.22	> 0.44 - 0.65
E	> 0.75 - 1.4	> 49 - 75	> 0.75 - 1.14	> 0.65 - 1.0
F	≤ 0.75	variable	≤ 0.75	variable

When the road is examined in parts in HCM, it gives us more than one PLOS table, as shown in Table 3.15, since it looks at the cases with platooning in some examination places separately. However, at the end of the day, the level of service rating is chosen by taking the lowest degree among them.

Table 3.15. Platoon-Adjusted PLOS Criteria for Walkways and Sidewalks HCM (2010)

LOS	Space (m2/p)	Flow Rate (p/min/m)
A	> 49	≤ 1.6
B	> 8 - 49	> 1.6 - 10
C	> 4 - 8	> 10 - 20
D	> 2 - 4	> 20 - 36
E	> 1 - 2	> 36 - 59
F	≤ 1	> 59

Each time a pedestrian level of service review application is made for HCM, whether interrupted or uninterrupted, the process starts with the determination of effective walkway width (W_E). Then the pedestrian flow rate (v_p) is calculated. Finally, before determining the PLOS for the region, the average pedestrian space (A_p) is found. For this, the basic equations that we will use in our study are given below.

$$W_E = W_T - W_O \tag{3.11}$$

Where

W_E = effective walkway width (m),

W_T = total walkway width (m), and

W_O = sum of widths and lengths from obstacles to the edge of the path (m).

$$v_p = \frac{v_{15}}{(15 * W_E)} \tag{3.12}$$

Where

v_p = pedestrian unit flow rate (p/min/m),

v_{15} = peak 15-min flow rate (p/15-min), and

W_E = effective walkway width (m).

Figure 3.2. is a schematic for calculating effective pathway width that depicts common obstructions and the estimated width of the walkway they avoid. Table 3.16 details the width of the pathway that is set by curbs, buildings, or other immovable obstacles. When specific configurations of walkways are unavailable, Table 3.16 values may be utilized. The effective length of an occasional obstruction is believed to be five times its effective breadth. Therefore, the average impact of occasional obstacles such as trees and poles must be computed by multiplying their effective widths by their effective lengths in relation to their average separation.

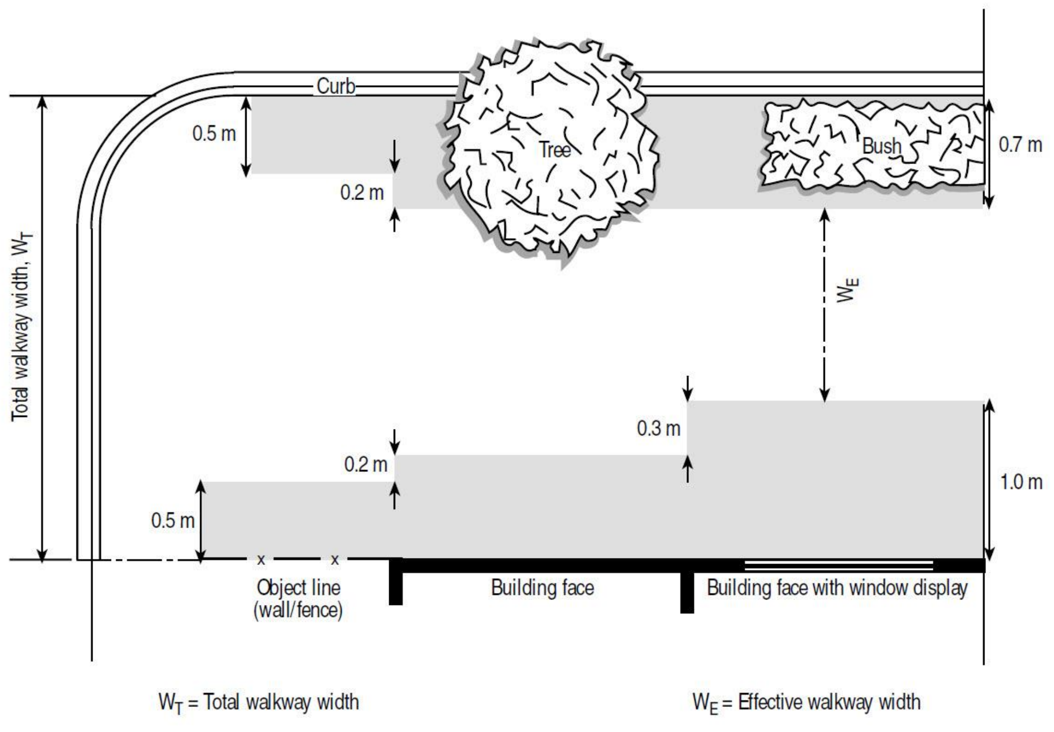

Figure 3.2. Width Adjustments for Fixed Obstacles HCM (2010)

Table 3.16. Preemption of Walkway Width HCM (2010)

Obstacle	Approximately Width Preemted (m)
Street Furniture	
Light pole	0.8 - 1.1
Traffic signal poles and boxes	0.9 - 1.2
Fire alarm boxes	0.8 - 1.1
Fire hydrants	0.8 - 0.9
Traffic signs	0.6 - 0.8
Parking meters	0.6
Mail boxes (0.5 m x 0.5 m)	1.0 - 1.1
Telephone booths (0.8 m x 0.8 m)	1.2
Waste baskets	0.9
Benches	1.5
Public Underground Access	
Subway stairs	1.7 - 2.1
Ventilation grates in subways (raised)	1.8+
Transformer vault ventilation gratings (raised)	1.5+
Landscaping	
Trees	0.6 - 1.2
Planter boxes	1.5
Commercial Uses	
Newsstands	1.2 - 4.0
Vending stands	variable
Promotional displays	variable
Retail displays	variable
Streetside cafés (two rows of tables)	2.1
Building Protrusions	
Columns	0.8 - 0.9
Stoops	0.6 - 1.8
Cellar doors	1.5 - 2.1
Standpipe connections	0.3
Awning poles	0.8
Truck docks (trucks protruding)	variable

Garage entrance/exit	variable
Driveways	variable

Note:

1. To account for pedestrian avoidance distance, 0.3 to 0.5 m must be added to the preemption width of individual barriers. Widths are measured from the curb or building face to the edge of the item. Source: Pushkarev and Zupan (2).

3.2.2. SCI – Landis Method

According to Landis (2002), a method is required to objectively assess pedestrians' perceptions of roadside security and comfort. This quantification or mathematical connection will quantify how well highways accommodate pedestrian traffic. It will essentially assess the pedestrian service level (PLOS) in a road setting. Such a gauge of walking conditions will be of considerable use in road section design and in assessing and prioritizing the sidewalk reinforcing needs of existing roads.

In order to construct more effective pedestrian environments, roadway planners need answers to the following questions: how far walkways should be placed from moving traffic, what type of cushioning or protective barriers are required and when they should be employed, and how wide the sidewalk should be.

For more walkable cities and transportation systems, it is already common knowledge that roadside pedestrians are exposed to a number of elements that have a substantial impact on their perception of safety and comfort. These elements may be categorized under three main performance criteria that describe the roadside pedestrian environment: (a) walkway capacity, (b) walking environment quality, and (c) pedestrian perception of motor vehicle traffic safety.

Landis et al. (2002) performed various Pearson Correlation analysis using SAS program on various traffic and road variables. As the Sprinkle institute, a lengthy list of probable key independent factors that influence pedestrians' perception of security or pleasure on the road was compiled and then examined using stepwise regression during the method's construction. The long list is based on: (a) Findings of Pearson Correlation analyses; (b) many significant metropolitan area pedestrian strategy, which were determined by group consensus and were now approved as essential variables during the progress of the previous Roadside Pedestrian Conditions Concept; and (c) exhaustive recursive experimenting of section groupings with similar levels of independent variables. The exhaustive list of significant criteria that emerged includes, but was not limited to, the following:

- Elements of lateral separation between people and vehicular traffic, include
  - Availability of sidewalk,
  - Width of the walkway,
  - Separators between the sidewalk and automobile driving lanes,
  - Barriers present inside the buffer zone,
  - Availability of on-street parking,
  - Outside travel lane width and
  - Presence and width of bike lanes or shoulders;
- Volume of Motor Vehicle;
- Speed effect;
- Heavy vehicles; and
- Driveway access frequency.

The Landis Method measures the service quality of the sidewalk by considering the pedestrian's perceptions of safety and comfort. These elements lead to a complicated evaluation of a road section, as shown in the below-described model proposal.

$$PLOS = -1.2021 \ln(W_{ol} + W_l + f_p * \%OSP + f_b * W_b + f_{sw} * W_s) + 0.253 \ln(Vol_{15}/L) + 0.0005SPD^2 + 5.3876 \quad (3.13)$$

Where,

W_{ol} = Width of the outer lane (feet),

W_l = Shoulder or bike lane width (feet),

f_p = coefficient of effect of on-street parking (= 0.20),

$\%OSP$ = % of section with on-street parking

f_b = Buffered area barrier coefficient (= 5.37 for 20-foot-apart tree spacing)

W_b	=	buffer width,
W_s	=	sidewalk width (feet),
Vol_{15}	=	The average volume of traffic within a 15-minute interval.
L	=	number of total (through) lanes (for road or street),
SPD	=	average speed of vehicular traffic (mph),
f_{sw}	=	sidewalk existence coefficient = 6 – 0.3W_s.

The resultant Model Score is then compared to the graph in Table 3.17. for grading between LOS A and LOS F.

Table 3.17. Level of service categories (Landis et al., 2002)

Level of Service	**LOS Value**
A	LOS≤1.5
B	1.5<LOS≤2.5
C	2.5<LOS≤3.5
D	3.5<LOS≤4.5
E	4.5<LOS≤5.5
F	LOS>5.5

3.2.3. Mozer's PLOS Evalutaion Method

In Mozer's (1997) study, the suitability of a road section for pedestrian movement is examined. The pedestrian-friendliness of a street segment is determined by four key dimensions: walkarea spacing, walkarea-outside traffic buffer, outside traffic volume, and outside traffic vehicular speed, as well as three secondary variables: walking space penetrations, heavy vehicle amounts, and intersection waiting time. These are explained in further depth below. Mozer (1997) decided to go beyond the classic level of service definitions and find it using stress level. Each of the basic parameters has its own tables and equations. A stress level is estimated using a numerical scale from 1 to 5 for each parameter, and in their averages the secondary parameters are added as decimals. The final score corresponds to a certain level of service (A-E) in relation to a particular table.

- Walkarea Width-Volume

This is the most essential characteristic for pedestrians, according to Mozer, because it gauges the safety of work locations. Since this is the most important component, it is given double weight in the computations. The width of the walking area is determined by the following relation and Stress Level grades are shown in Table 3.18.

$$WALKAREA\ WIDTH\ VOLUME\ (wwv) = PHV * (1 + NPM) / (WWA / (TP * FD)) \quad (3.14)$$

Where,

PHV = Peak hour pedestrian volume, all directions.

NPM = Mode split that is none pedestrians.

WWA = The width of the pedestrian walkway in meters.

TP = Travel Pattern Factor; enter '1' if the route is predominantly unidirectional and '2' if it is predominantly bidirectional.

FD = Facility Design Factor; input '1' if the facility fulfills Americans with Disabilities Act criteria (steep slope, side slope), and '5' if it does not.

Table 3.18. SL Walkarea Width-Volume (Mozer, 1997)

Grade	**Score**
1	100
2	200
3	300
4	400
5	>500

- Walkarea-Outside Lane Buffer Factor

The ideal buffer, according to Mozer, is a planted strip, although parking on the street, a "street furniture" area, or a jersey barrier also enhances pedestrian conditions. SL for the outer lane buffer of the walkway is defined by the following relationship and Stress Level grades are shown in Table 3.19.:

$$\text{WALKAREA} - \text{OUTSIDE LANE BUFFER FACTOR (lbf)} = \text{WBW} / \text{EQ} \quad (3.15)$$

Where,

WBW = Walkarea-Outside Lane Buffer Width

EQ = Use '1' for live material and '2' for non-living material for Aesthetic Quality.

Table 3.19. SL for walkarea-outside lane buffers (Mozer, 1997)

Grade	Point (meter)
1	>1.7
2	1.3
3	1
4	0.6
5	<0.3

- Outside Lane Volume

Peak hour volumes are used to compute outside lane volumes. The equation below determines the peak hour traffic per lane and stress level grades are shown in Table 3.20.:

$$\text{PEAK HOUR VOLUME PER LANE (vpl)} = \text{ADT x K (factor)} / \text{LN} \quad (3.16)$$

ADT = Average Daily Traffic

K = Determines the percentage of ADT that happens during the peak hour. K equals 10% for urban regions.

LN = Quantity of lanes.

The volume SL for the outer lane is derived using the following equation:

$$VPL/\,25 = SL(SL + 1) \text{ where SL <5.} \tag{3.17}$$

Table 3.20. SL for Outside Lane Volume (Mozer, 1997)

Grade	Point (veh./hr/lane)
1	<50
2	150
3	300
4	500
5	>750

- Outside Lane Speed

Pedestrians' experience is affected by the speed of motor vehicles near to the pedestrian walkway. The average speed of 85 percent of the traffic is measured and Stres Level grades can be seen in Table 3.21.

Table 3.21. SL Speed of Vehicular Traffic (Mozer, 1997)

Grade	Point (km/h)
1	<16
2	32
3	48
4	64
5	>80

- Walkarea Penetrations Factor

Crosswalks present pedestrians with potentially hazardous turning actions. This element contributes to the primary stress total. The connection below determines peak hour walking penetration SLs:

$$PEAK\ HOUR\ OUTSIDE\ PENETRATIONS\ FACTOR\ (php)\ =$$

$$N\ x\ APHP\ x\ (1000\ /\ D)\ /\ 100 \quad (3.18)$$

Where,

N = Number of Driveways

APHP = Peak Hour Average Penetrations per Driveway

D = The segment's length in meters. This is a multiplier for the number of driveways per kilometer.

- Heavy Vehicle Factor

This element contributes to the main stress total. The heavy vehicle factor (hvf) SL is based on the proportion of heavy vehicles that utilize the sector. This number is summed as a decimal to the principal stress level.

- Factor of Intersection Waiting Time

The waiting time factor (wtf) is the proportion of one minute that a pedestrian waiting time to pass the crossing. If a stationary phase signal is present at the junction, 50% of the'standby phase' is utilised. If a 'walk signal' is activated in response to a request, the time between claiming the right-of-way and getting the signal is considered. If the intersection does not have a traffic light, the average wait time for an opening during rush hour is utilized. The number is added as a decimal to the principal stress level.

3.2.4. Tan Dandan Method

From Tan Dandan's (2007) perspective, walking is an independent act of a person; It is impacted by the physiology and psychology of pedestrians; thus, assessment considerations should include psychological features such as walkway facilities and traffic flow operation, as well as physiological aspects such as the age and gender of pedestrians. The analysis of pedestrian service level for sidewalks should include pedestrian perceptions, conventional flow volume and capacity, and other aspects that impact walking comfort and safety to produce a pleasant walking space.

PLOS characteristics are often elements that impact pedestrian comfort and safety. Tan D. et al. (2007) did their study in China with proposing 5 affected factors.

- Road transect outline

Road transect form refers to the lateral components between pedestrians and automobile or bicycle traffic, such as the existence and effective width of the sidewalk, bumpers between the walkway and automobile or cycling lanes, etc.

- Pedestrian flow characteristics
- Characteristics of vehicular and bicycle flow

Comfort and safety of pedestrians are impacted by the volume and speed of automobiles and bicycles. In the event of heavy traffic and fast-moving automobiles or bicycles, pedestrians may feel vulnerable and in danger.

- Obstructions on the sidewalk
- The frequency of driveway access

Adjusting the access to a driveway can interrupt the flow of pedestrian traffic, resulting in lower pedestrian comfort and safety.

In the study conducted by Tan D. et al. (2007), LOS was evaluated by assessing the relationship between the subjective impressions of pedestrians and the quality of roadside amenities. By analyzing the connection between pedestrian LOS and contributing variables, the variables that significantly affect the relationship between LOS and pedestrian are listed below.

- The bicycle flowrate , Q_B
- The pedestrian flowrate, Q_P
- The vehicular flowrate, Q_V
- The frequency of access to the driveway , P
- The distance between the roadway and the sidewalk, W

Considered to be the most likely key elements influencing pedestrians' perceptions of safety, the aforementioned variables were deemed to be the ones stated above.

Consequently, the following model was developed and the grading system is shown in Table 3.22. as in the rank system of LOS:

$$PLOS = -1.43 + 0.006Q_B - 0.003Q_P + \frac{0.056Q_V}{W_r} + 11.24(P - 1.17P^3) \quad (3.19)$$

Where,

Q_B = bicycle traffic within a five-minute interval

Q_P = pedestrian traffic within a five-minute interval

Q_V = vehicle traffic within a five-minute interval (pcu)

P = Quantity of driveway access per meter

W_r = distance between walkway and car lane (m)

Table 3.22. Level of service categories (Tan D. et al, 2007)

Level of Service	LOS Value
A	LOS<2.0
B	2.0≤LOS<2.5
C	2.5≤LOS<3.0
D	3.0≤LOS<3.5
E	3.5≤LOS<4.0
F	LOS≥4.0

3.2.5. Disabled PLOS Method

In the study conducted by Moeinaddini et al. (2013), both the key elements that enhance pedestrian travel conditions and their relevance were assessed and utilized for rating the pedestrian characteristics of existing roads. Numerous pedestrian indicators are provided with evaluation guidelines that apply scientific methods. In addition, the study focuses on real improvements to pedestrian conditions as opposed to theoretical analysis. The current study applies a point-based DPLOS to assess the accessibility of urban roadways. Due to the fact that each of the ten analyzed indicators has a unique impact on DPLOS, they may have coefficients that contribute to the construction of the following DPLOS model.

$$DPLOS = \sum_{i=1}^{10} c_i DI_i$$

(3.20)

Where,

DPLOS = disabled pedestrian level of service;

i = indicator number;

c = coefficient of disabled pedestrian indicator;

DI = disabled pedestrian indicator score.

The coefficients for each indicator are determined. The coefficient of each impaired pedestrian indication on DPLOS may be used to calculate its weight (c). Consequently, c reflects the relevance and priority of indicators. Indicators are illustrated in Table 3.23.

In this method, the DPLOS percentage is calculated to make it easier to understand the DPLOS value as a specific rating system. This value continues to be used within the method as a percentage of DPLOS available, corresponding to the ideal DPLOS.

$$DPLOS\% = \frac{DPLOS}{\sum_{i=1}^{10} C_i} * 100$$

(3.21)

Where,

DPLOS% = proportion of DPLOS;

DPLOS = disabled pedestrian level of service;

i = indicator number; and

c = coefficient of disabled pedestrian indicator.

This model made by Moeinaddini et al. (2013) is only for DPLOS. Below equations to be used in the study can be seen in Table 3.23. The equivalent of the percentage value found in the result is shown in Table 3.24. with the LOS grading system.

Table 3.23. Indicators for collector/calculation descriptions (Moeinaddini et al., 2013)

(1)	Slope
Standard: sidewalk slope ≤ 2%	
DI1= C/N	(3.22)
C = section of sidewalk with a normal grade (m2)	
N= $\begin{cases}(length\ of\ street\ (both\ sides) - length\ of\ intersection) * 1.8 & if\ W < 1.80\ m \\ (length\ of\ street\ (both\ sides) - length\ of\ intersection) * W & if\ W \geq 1.80\ m\end{cases}$ (3.14)	
W = sidewalk width (m)	
If W fluctuates at several points along the street:	
DI1=$(\sum DICi * Li)/$[length of street (both sides) − length of intersections]	(3.23)
i =1, 2, 3, ..., k (different parts of street with various widths of sidewalk)	
DICi = Ci/Ni	(3.24)
Ci = area of sidewalk with standard slope in Section i (m2)	
Ni=$\begin{cases}(length\ of\ street\ (in\ section\ i)) * 1.8 & if\ W < 1.80\ m \\ (length\ of\ street\ (in\ section\ i)) * W & if\ W \geq 1.80\ m\end{cases}$	(3.25)
Li = length of street (in Section i) (m)	
(2) Elevator	
Standard:	
• Each skybridge must be equipped with elevators, and all elevators must be equipped with buttons and audio systems	
• Elevator shall be supplied at both sky bridge entrances and exits with minimum internal dimensions of 1.4 1.4 m;	
• Call button height should be between 0.9 and 1 m;	
• Elevator interior should include a railing	
DI2 = C/N	(3.26)
C = number of standard elevators	
N = number of elevators needed on the street	
DI2 = 0 if street does not need elevator	

(3) Curb ramp Standard: • Curb ramps must be positioned or shielded to prevent obstruction by parked cars. • Minimum landing size of 1.2 x 1.2 meters and maximum slope of 2 percent • Minimum ramp width of 1.2 meters; ramp slope between 5 and 8.3% • Maximum flaring side cross slope 10 percent
$DI3=\begin{cases} 1 & if \quad P \geq 1 \\ P & if \quad P < 1 \\ 0 & if \quad street\ does\ not\ need\ a\ curb\ ramp \end{cases}$ (3.27) P = C/N (3.28) C = amount of standard curb ramps N = total number of curb ramps required for the roadway
(4) Wheelchair-accessible drinking fountain Standard: • Maximum height of 0.91 meters • Positioned inside furnishing zones near playgrounds or outdoor dining areas and close to shelters • Every 400 meters
DI4 = C/N (3.29) C = street length with standard wheelchair-accessible drinking fountains + their support length (m) N = length of street (m)
(5) Tactile pavement Standard: guiding tile • A space of 0.60 to 0.80 m must be given between the edge of the pathway, the boundary wall, and any obstruction; • The elevated component of the surface must have a minimum width of 0.30 m and a height of about 0.005 m. • Tactile pavement ought to be tinted (preferably canary yellow)
$DI5=\begin{cases} 1 & if \quad P \geq 1 \\ P & if \quad P < 1 \end{cases}$ (3.30) P = C/N (3.31) C = standard guiding tactile pavement length (m) N = the required length of guiding tactile pavement (m)

(6) Warning tile

Standards:

• Detectable warnings should be put at the bottom of curb ramps and other areas, including elevated crosswalks and raised junctions, median and island boundaries, at the edge of transit platforms, where train lines cross the sidewalk, and where walking direction changes.

• Detectable warnings must be put throughout the whole width and 0.60 meters up the ramp. These warnings should be positioned 0.15 to 0.25 meters from the bottom of the curb.

• Smooth surfaces should be supplied adjacent to detectable signs in order to increase contrast.

$$DI6=\begin{cases} 1 & if \quad P \geq 1 \\ P & if \quad P < 1 \end{cases} \tag{3.32}$$

P = C/N (3.33)

C = number of standard warning tactile pavement rows

N = number of tactile pavement rows required for roadway safety

(7) Ramp

A surface for walking with a running slope more than 5 percent Standard:

• Maximum slope 8.3 percent

• Minimum width of 1.2 meters

• Compliant railing

$$DI7=\begin{cases} 1 & if \quad P \geq 1 \\ P & if \quad P < 1 \\ 0 & if \quad street\ does\ not\ need\ ramp \end{cases} \tag{3.34}$$

P = C/N (3.35)

C = number of standard ramps

N = number of ramps required for the roadway

(8) Toilet

Standard:

• Minimum of 1.7 × 1.8 m

• Should be positioned in close proximity to every bus stop and fast transit station

• Restrooms should be located every 500 to 800 meters.

DI8 = C/N (3.36)

C = length of roadway with standard accessible toilets plus their supportlength (m)

N = length of the road (m)

(9) Grade

Standard: sidewalk grade ≤ 5%

DI9 = C/N (3.37)

C = Section of sidewalk with standard grade (m2)

N=

$$\begin{cases} (length\ of\ street\ (both\ sides) - length\ of\ intersection) * 1.8 & if\ W < 1.80\ m \\ (length\ of\ street\ (both\ sides) - length\ of\ intersection) * W & if\ W \geq 1.80\ m \end{cases}$$

(3.38)

W = width of sidewalk(m)

If W varies in different portions of street

DI9=($\sum DICi * Li$) /[length of street (both sides) – length of intersections] (3.39)

i=1, 2, 3, ... k (different parts of street with various widths of sidewalk)

DICi = Ci/Ni (3.40)

Ci = area of sidewalk with standard grade in Section i (m2)

$$Ni=\begin{cases} (length\ of\ street\ (in\ section\ i)) * 1.8 & if\ W < 1.80\ m \\ (length\ of\ street\ (in\ section\ i)) * W & if\ W \geq 1.80\ m \end{cases} \quad (3.41)$$

Li = length of street (in Section i) (m)

(10) Signal

Standard:

• At a crossing, accessible pedestrian signals must be at least 3 m apart and 1.5 m from other traffic lights.

• Position the device no closer than 0.75 m and no farther than 3 m from the curb;

• It should be no further than 1.5 m from the crossing;

• A sufficient countdown timer should be given;

• A wheelchair user should be able to reach the button; • An audible signal is required.

DI10 = (SPI+CPI+WPI+API)/4 (3.42)

$$SPI = \begin{cases} 1 & if \quad P1 \geq 1 \\ P1 & if \quad P1 < 1 \end{cases} \quad (3.43)$$

P1= SP/N (3.44)

SP = signals with first, second, and third standards

N = total number of signals the street needs

$$CPI = \begin{cases} 1 & if \quad P2 \geq 1 \\ P2 & if \quad P2 < 1 \end{cases} \quad (3.45)$$

P2 = C/N (3.46)

C = signals with fourth condition

$$WPI = \begin{cases} 1 & if \quad P3 \geq 1 \\ P3 & if \quad P3 < 1 \end{cases} \quad (3.47)$$

P3 = W/N (3.48)

W = signals with fifth condition

$$API = \begin{cases} 1 & if \quad P4 \geq 1 \\ P4 & if \quad P4 < 1 \end{cases} \quad (3.49)$$

P4 = A/N (3.50)

A = signals with sixth condition

DI10 = 0 if there is no signal

Table 3.24. PLOS% Interpretation (Moeinaddini et al., 2013)

PLOS% Rating	Model Score	Interpretation
A	80 - 100	Numerous eminent disabled-pedestrian amenities are of the highest level (extremely pleasant)
B	60 - 79	Some renowned handicapped-accessible pedestrian facilities are of high grade (acceptable)
C	40 - 59	Existence of impaired pedestrian facilities of average quality (rarely acceptable), but space for development
D	20 - 39	Poor quality (uncomfortable) and inadequate impaired pedestrian facilities
E	1 - 19	Lowest quality (unpleasant)
F	0	No standard pedestrian facility for disabled pedestrians (very unpleasant)

3.2.6. Sarkar's PLOS Method

The evaluation of pedestrian comfort proposed in Sarkar S.'s article (2002) is comprised of two distinct assessments: Service Level assessment (physical and psychological comfort) which provides standards for generally desired and unwanted comfort conditions at the macro level, and Quality Level assessment (physiological comfort) for the micro level comfort conditions. The evaluation scale consists of five classes: A, B, C, D, and F. These comfort levels are determined by physical, physiological, and psychological factors. Physical comfort characteristics include a sufficient walking route, continuous sidewalk, an unobstructed walking path, a pleasant walking surface, a place to rest, and protection from adverse weather conditions. Psychological comfort is characterized by the ability to sustain the appropriate walking pace and the capacity to engage in a range of pedestrian activities. Noise and air pollution have a negative impact on physiological comfort. This technique provides a qualitative evaluation of the pedestrian environment and is not quantitative.

In calculating Service Levels for Pedestrian Comfort, the suggested Service Levels A-F in Table 3.25 utilized existing principles, concepts, and ideas pertaining to pedestrian comfort requirements. The Comfort Service Levels are based on cognitive and emotional characteristics that reduce physical fatigue and meet psychological requirements. Additionally, the study describes the design features responsible for the best and least pleasant urban sidewalks for disadvantaged users.

For the evaluation of Quality Levels A-F for Pedestrian Comfort, in addition to the comfort level specified in Service Levels, there are a variety of micro-level characteristics that promote the comfort of pathways. In this study by Sarkar (2002), there are 4 main micro conditions. These;

- Provision of resting areas and additional seating,

Walking requires more energy and effort than other forms of transportation, particularly for vulnerable people. As demonstrated in Table 3.26, the quality of seats impacts the amount of comfort pedestrians perceive.

- Protection from inclement weather,

Pedestrians are susceptible to inclement weather. They prefer protection from precipitation, snow, sleet, and excessive heat and cold. Table 3.27 depicts Quality Levels.

- Level of noise,

Walkways adjacent to major roadways are especially prone to noise pollution. The recommended Quality Levels in this study, as shown in Table 3.28, have been created utilizing these design options or their absence.

- Air pollution level.

According to Sarkar (2002), the pollution level determines the kind and length of outdoor activities along the sidewalks. Possible solutions are shown in Table 3.29 together with Quality Levels.

These micro-level factors that relate to degrees of comfort are distinct entities that make up the Quality Levels.

Grades assignation using Service or Quality Levels as a methodological process require six steps for the Sarkar Method. The procedure begins with a comprehensive site study that examines the macro and micro comfort qualities of the sidewalks. Survey checklists need to be designed using the guidelines in Tables 3.25 – 3.29. The step two is to ensure that all information collected during the survey is classified systematically. The third stage consists of comparing the characteristics of the research area with the Service Level specifications one by one. This procedure leads to the fourth phase, which entails picking Service and Quality Levels that conform to the majority of the observed features in the research field. The degrees assigned to each segment are shown in a matrix at the fifth stage in order to measure the degree of change in the street's pleasant conditions. Based on the idea that "minimum capacity determines the line’s capacity," the sixth stage entails awarding a grade to the whole walkway segment. Using this method, an overall score will be assigned to the investigated roadway depending on the lowest grade earned for each segment. Each side of the street has its own rating, so that every street with a double-sided sidewalk will have two grades. After accumulating the comments for all examined street segments, they may be summarized in an Excel spreadsheet with comfort indications. This information is perfect for qualitative comparisons between streets and is also beneficial for determining where improvements should be made.

Table 3.25. Physical and psychological components of Service Levels A through F for the comfort of pedestrians. Sarkar (2002)

Service Levels	**Physical effort minimized**	**Reduced physical effort for pedestrians with burdens and people with special requirements**	**Pedestrian activities accommodated**
A	- The pathway has been built to allow people to easily select and maintain their chosen walking speed. - Efforts have been made to include shortcuts or reduce clashes with other modes and street furniture.	- Wheelchair-bound pedestrians and others with special needs have more than sufficient room for unrestricted movement*	- Diverse pedestrian activities are accommodated.
B	- Able to select and maintain appropriate speed without difficulty. (less desirable pathway than Level A)	- Wheelchair-bound and special-needs pedestrians have more than sufficient room to move about unimpeded.	- Diverse pedestrian activities are accommodated.
C	- Pedestrians must modify or navigate to use the walkway due to the inappropriate placement of street furniture and other obstacles. - The layout and breadth of the walkway are unsuitable for significant pedestrian traffic.	- Wheeled pedestrians and individuals with special needs have trouble navigating the sidewalk.	- Diverse pedestrian flows, activities, and motions necessitate collaboration and maneuvering.
D	- Obstacles and barriers enhance the physical exertion of pedestrians. - Sidewalks are congested with illegally parked cars, signage, and other impediments to pedestrian movement. - Driveway vehicles obstruct the walkway.	- Because of the inadequate walking surfaces and absence of ramps, disabled and special-needs walkers are unable to use the pathways.	- Unsuitable walkways for typical foot traffic. Pedestrians stroll in single file, cross the street, etc.
F	- Walkways are inaccessible owing to a substandard walking surface, flooding, and freezing weather. - No sidewalks exist; pedestrians must use the road.	- As necessary road users, pedestrians with impairments and people with special needs are exposed to vehicle traffic.	- Inexistent or inaccessible walkways.

*Historic districts are excluded.

Table 3.26. Seating with Quality Levels A-F per 150 meters. Sarkar (2002)

Quality Levels	**Resting places***						**Other Seating**	**Secondary Seating**	
	Dimensions	**Utilizable with ease**	**insulated from road noise**	**Protection from elements**	**Setback from effective walkway**	**No. of resting areas****	**Benches**	**Street Furniture**	**Other**
A	Spacious, seating area	Very comfortable seating	Completely (Vehicles are banned)	Well protected	More than adequate	At least one	Yes	Seating is provided by specially constructed items.	Low walls, green areas, and steps
B	Spacious, seating	Comfortable seating	Adequately protected by canopies, trees, arcades	Adequate	At least one	Yes	Specially designed.	Low walls, steps	
C	None	None	None	None	None	None	Well designed	Some street furniture may be	Low walls, steps (optional)
D	None	None	None	None	None	None	Average	None have been developed as additional seating	Low walls or steps
F	None	None	None	None	None	None	Poor/Vandalized/ Non-existent	None	None; design (high walls, fences etc.) discourages sitting

* Based on land use and activity, the user can scale down or adjust proposed restrictions.

** Resting zones are particularly designed enclaves for sitting and engaging in activities by pedestrians.

Table 3.27. Comfort Rating Levels A-F in adverse weather situations (every 150m).Sarkar (2002)

Quality Levels	Protection from weather	Wind gusts during winter	Protection at bus stops	Drinking fountains	Other facilities
A	Available options include climate-controlled, tree-shaded arcades and specific cooling elements.	Mild to none	Well protected with seating.	Available	Beverage vending machines, vendors
B	Provide adequate protection via arcades, canopies, and trees	Mild to none	The protection provided by transit shelters with chairs is adequate.	Available	Vendors or beverage vending machines
C	Partial - shaded trees flank the path and canopies are noticed intermittently.	Moderate wind gusts	The protection offered by transit shelters is adequate. There are no seats in shelters for public	None	None
D	Inadequate - the placement of shade trees is haphazard.	Strong	There are no shelters at transit stops, however there may be seats.	None	None
F	Not protected	Very strong and extremely uncomfortable.	There is no cover or sitting available. The bus stop is located on the travel lane.	None	None

Table 3.28. A through F Quality Levels for noise on paths.Sarkar (2002)

Quality Levels	Noise levels	Methods for noise reduction and causes of insufficient noise reduction	Distaned Conservation (1-1.5 m)	Outdoor activities
A	• Extremely low during the day and night • Less than 50 dba	• Banning Vehicles • Walkways are enclosed completely	• Possible	• Very high: Users are reported to be seated, observing, and playing
B	• Low during the day and night • 50-65 dba	• Regulating traffic volume by means of traffic management • Designing broad paths with vegetation or berms • Layout of semi-enclosed arcades and landscape	• Possible	• High: It is noticed that users are seated, observing, and playing.
C	• Acceptably loud throughout the day (>65 but 75 dBA) • Low during night	• (a) the vehicular traffic volume has been reduced by converting highways into I one-way streets with one lane and parking/traffic calming; (ii) two-way streets with one lane in each direction and parking have contributed to the noise reduction. (b) enforcing the speed limit of 50-55 km/h or 30-35 mph.	• Easier when voices are raised slightly	• Moderate: Very few users are sitting, watching, or playing.
D	• Moderately to very loud all day (>65-90 dB) • Intermittently	• The noise level has not been lowered as a result of the following conditions: The streets consist of I multilane one-way streets or (ii) multilane two-way streets. b) The pathways lack a barrier against road noise. (c) the measured speed exceeds 55 kph or 35 mph.	• Difficult	• Low: There are no outside activities, playing, or sitting. Very few individuals
F	• Moderately to very loud throughout day and night (65-90 dB)	• (a) the highways are either I multi-lane one-way streets or (ii) multi-lane two-way streets. (b) the roadways are either I multi-lane one-way streets or (ii) multi-lane two-way streets. b) The walkways are not buffered from traffic noise by vegetation or wide sidewalks.	• Impossible	• None.

Table 3.29. Ratings A through F for sidewalk air pollution. Sarkar (2002)

Quality Levels	Pollution Reduction Strategies or Absence
A	• Vehicle traffic is prohibited. • Walking and cycling have been encouraged by design. • Excellent air circulation exists. • Paths are well manicured.
B	• Regulation of automotive traffic volume. • Encouragement of eco-friendly modes via design. • Consistent air circulation prevents the accumulation of pollutants. • Plants arranged in tiers along the paths. • Unique structures, such as berms or barriers, that divide pedestrian paths from automotive traffic.
C	• Average air circulation prevents the dispersion of contaminants from automobile traffic. • Building heights vary and streets do not include canyons • Trees are placed along pathways to somewhat reduce airborne particulate pollution.
D	• Poor air circulation makes it impossible to remove all the pollutants caused by heavy to moderate traffic. • Some trees are planted along the pathways. Or, • No particular features that separate pedestrian pathways from automobile traffic, nor are there any traffic limits during certain times.
F	• Traffic jams happens often. There is a great deal of traffic. • Automobile exhaust and other pollution are perceptible and physically unpleasant. Onlookers witness pedestrians using masks or other forms of protection. • Due to the street's breadth and building's orientation, air circulation is exceedingly poor. • Along the walks, there are some trees planted. Or, • There are no particular designs that divide the pedestrian walkways from the automotive traffic, nor are there any limits on vehicular traffic during certain hours.

3.2.7. Trip Quality Method

Jaskiewicz (1999) identified nine markers, including enclosure/definition, path network complexity, structure articulation, space complexity, visibility, buffering, tress, sloped ceilings roof types, and physical components/condition. Each of these nine measures, according to Rapoport and Jacobs, is derived from a combination of security considerations, quantity and efficiency concerns, and quality intricate details.

In Jaskiewicz's (1999) study, using a simple grading system, the extent to which particular target regions met the nine specified assessment criteria was determined. The range of appropriateness was well covered by a scale from 1 to 5: 5 = best, 4 = acceptable, 3 = ordinary, 2 = bad, and 1 = very bad. As stated in Table 3.30., the scores may then be totalled and averaged to get an overall LOS.

Table 3.30. Rating of Pedestrian LOS Using the Trip Quality Method (Jaskiewicz,1999)

PLOS	**Average Score***	**Definition**
A	4.0 ≤ Value ≤ 5.0	Very Good
B	3.4 ≤ Value ≤ 3.9	Pleasant
C	2.8 ≤ Value ≤ 3.3	Acceptable
D	2.2 ≤ Value ≤ 2.7	Uncomfortable
E	1.6 ≤ Value ≤ 2.1	Bad
F	1.0 ≤ Value ≤ 1.5	Very Bad

*Average Score= (I1+I2+ …I9)/9

Evaluation Scores

Indıcators	Best	Good	Average	Bad	Very Bad
I1 to I9	5	4	3	2	1

According to Jaskiewicz (1999), suitable planning level recommendations for pedestrian facilities range from LOS A to LOS C; LOS A is the standard for city centers while LOS C is utilized for paths outside of city centers. Pedestrian LOS D may be allowed in certain situations, as long as basic safety parameters are observed.

The nine recommended assessment factors are focused on aesthetics, safety, and simplicity of mobility and are essential for achieving the high pedestrian service criteria outlined in this text. These measures try to develop this concept from a pedestrian perspective while determining the pedestrian service level, taking into account the aesthetics and safety as well as the volume and capacity. In order to improve the pedestrian experience, it is important for planners and engineers to be able to identify what distinguishes a good pedestrian environment from a bad environment.

3.2.8. Gainesville Method

The Gainesville bicycle and pedestrian LOS performance metrics by Dixon, Linda B. (1996) analyze highway corridors using a score system ranging from 1 to 21, yielding PLOS grades ranging from A to F. (Table 3.31. and Table 3.32.). The grading system was designed with mutually exclusive or inclusive qualities in mind in order to identify all possible point combinations. Evaluations of pedestrian safety factors and the degree of auto-oriented development along the route are used to calculate pedestrian LOS ratings. Ratings for PLOS indicate the degree to which facility features favor pedestrian use. The concept is founded on the premise that a critical mass of factors must be present in order to attract non-motorized excursions. The technique applies to corridor evaluations on urban and suburban arterial and collector roadways. The approach is straightforward and simple to implement, however the selection of criterion points is arbitrary. The pedestrian facility is either continuous or discontinuous in the computation.

Table 3.31. Pedestrian Level-of-Service (Dixon, 1996)

Category	**Criteria**	**Points**
Pedestrian Facility	Lacking continuity or existence	0
Provided	Continuous on one side	4
(Max. value = 10)	Continuous on both sides	6
	Min. 1.53 m (5’) wide & barrier free	2
	Sidewalk width >1.53 (5’)	1
	Alternative off-street/parallel facility	1
Conflicts	Driveways & side streets	1

	Less than or equal to 40 seconds for	
(Max. value = 4)	Ped. Signal delay	0.5
	Reduced turn conflict implementation	0.5
	Crossing width less than 18.3 meters	0.5
	Posted speed	0.5
	Medians present	1
Amenities	Buffer not less than 1m	1
(Max. value = 2)	Benches or lights for pedestrian areas	0.5
	Shade trees	0.5
Motor Vehicle LOS	LOS = E, F, or 6+ travel lanes	0
(Max. value = 2)	LOS = D, & < 6 travel lanes	1
	LOS = A, B, C, & < 6 travel lanes	2
Maintenance	Major or frequent problems	-1
(Max. value = 2)	Minor or infrequent problems	0
	No problems	2
TDM/Multi Modal	No support	0
(Max. value = 1)	Support exists	1

Table 3.32. Pedestrian Level of Service Ratings (Dixon, 1996)

PLOS Rating	Scores
A	>17
B	>14-17
C	>11-14
D	>7-11
E	>3-7
F	3 or less.

3.2.9. Conjoint Analysis Method

Conjoint Analysis identifies the pedestrian LOS for sidewalks and crosswalks by integrating numerous characteristics that impact pedestrian traffic. This method's greatest aspect is that the qualities are determined by the "degree of priority" a user assigns to them. For sidewalks, breadth and separation, barriers, flow velocity, and cycling phenomena are taken into account. Attributes of pedestrian crossings include corner clearance, crossing options, turning vehicles, and delay. They are evaluated according to three levels, both the first level being the best. Muraleetharan (2006), referring to the LOS standards, determined a total of eight features and three levels for each feature. He used the two sets of attributes and levels shown in Table 3.33. and Table 3.34. to create the profile cards.

Table 3.33. Attributes and levels of intersection (Muraleetharan, 2006)

Level	Attributes			
	Space at Corner	**Crossing Facilities**	**Turning Vehicles**	**Delay**
1	Enough waiting & circulation space	Excellent facilities	No turning vehicle	Less than 10 seconds
2	Only waiting space is responsible	Stanard is provided but more needed	Left turning vehicles	From 10 to 40 seconds
3	Both spaces are not enough	Crossing facilities are lacking	Left & right turning vehicles	More than 40 seconds

Table 3.34. Features and Levels of sidewalk (Muraleetharan, 2006)

Level	Attributes			
	Width & Seperation	**Obstructions**	**Flow Rate (ped/min/m)**	**Bicycle Events**
1	More than 3m wide & excellent seperation	No Obstructions	Less than 24	≤60 events/h
2	From 1.5 to 3m & reasonable separation	From 1 to 5 obstructions per 100m.	From 24 to 49	From 61 to 144 events/h
3	Less than 1.5m wide & no seperation	More than 5 obstructions per 100m	More than 49	>144 events/h

Both sidewalk and pedestrian crossing assessments take into account two traffic-dependent and non-traffic-related characteristics. Since the scope of our study is confined to sidewalks and walkways, Table 3.35 contains just the sidewalk criterion for estimating the PLOS.

Table 3.35. Categories of level of service (Muraleetharan, 2006)

Level of Service	LOS Value
A	4.78<LOS
B	4.19<LOS≤4.78
C	3.61<LOS≤4.19
D	3.02<LOS≤3.61
E	2.44<LOS≤3.02
F	LOS≤2.44

The factors considered in this method were developed based on a comprehensive user survey conducted in Sapporo, Japan within and around the University of Hokkaido. The user survey includes benefit values for each level according to user responses.

3.2.10. Gallin – Australian Method

In her study, Nicole Gallin calculated PLOS based on design considerations (physical characteristics), geographical variables, and user characteristics.

Walkway width, pavement quality, impediments, passage possibilities, and support amenities are design elements. Location factors include accessibility, route surroundings, and the danger of vehicle conflict. User factors; pedestrian traffic, variety of path users, and individual safety.

The PLOS rating system consists of five degrees, from A to E. (here A - ideal conditions for motion and E - unacceptable conditions). Each component should be evaluated based on its quality and significance. The PLOS classification that will be utilized in the study is detailed in Table 3.37.

Table 3.36. Model Evaluation Sheet for Determining PLOS for Pedestrians (Gallin N., 2001)

Category	Factor	Weight	0 points	1 point	2 points	3 points	4 points
Design Factors (Physical Characteristics)	Path Width	4	No pedestrian path	0-1m	1.1 - 1.5m	1.6 - 2.0m	more than 2m wide
	Surface Quality	5	Unsealed and/or many cracks/bumps, i.e., of extremely low quality	poor quality	moderate quality, i.e. some cracks/ bumps etc.	reasonable quality, ie acceptable standard	Outstanding quality (continuous surface with little bumps/cracks, etc.)
	Obstructions	3	more that 21 obstructions per km	between 11 and 20 obstructions per km	between 5 and 10 obstructions per km	between 1 and 4 obstructions per km	no obstructions
	Crossing Opportunities	4	none provided, difficult to cross	several provided but badly situated	some provided and are reasonably well located but more are needed	The provision of suitable crossing facilities that are suitably positioned, or the absence of crossing facilities because they are unneeded.	dedicated pedestrian crossing facilities are provided at adequate frequency
	Support Facilities	2	non existent	few provided and badly situated	few provided and reasonably well located	numerous provied and strategically positioned OR absent but unnecessary	many provided and well located

Table 3.36.(cont'd) Model Evaluation Sheet for Determining PLOS for Pedestrians (Gallin N., 2001)

Location Factors	Connectivity	4	non existent	poor	reasonable	good	excellent
	Path Environment	2	uncomfortable atmosphere and near proximity to vehicle traffic	Poor environment, maybe within 1 meter of curb	acceptable environment, between 1 and 2m of kerb	reasonable surroundings, between 2 and 3 meters from the curb	Pleasant atmosphere, pedestrians more than 3 meters from the curb
	Potential for Vehicle Conflict	3	severe, more than 25 conflict points per kilometer	poor situation, between 16 and 25 conflict points per kilometre	moderate, ie 10 to 15 potential vehicle conflict points per km	reasonable, 1 to 10 or less conflict points per km	no vehicle conflict potential
User Factors	Pedestrian Volume	3	More than 350 per day	226 to 350 per day	151 to 225 per day	81 to 150 per day	Less than 80 per day
	Mix of Path Users	4	Most path users are not pedestrians.	Approximately 51 to 70% of path users are non-pedestrians.	between 21% and 50% non-pedestrian path users	less than 20% non-pedestrians	pedestrians only
	Personal Security	4	unsafe	poor	reasonable	good	excellent security provided

Table 3.37. Pedestrian LOS Grade Scale (Gallin N., 2001)

LOS Grade	LOS Scores
A	LOS ≥ 132
B	101 ≤ LOS ≤ 131
C	69 ≤ LOS ≤ 100
D	37 ≤ LOS ≤ 68
E	LOS ≤ 36

To evaluate the pedestrian LOS rating for a particular road stretch, a set of straightforward actions must be taken. These procedures include; a desktop evaluation of PLOS variables, onsite evaluation of PLOS variables, Calculate score for each factor, Determine the weighted score for each component, Determine the total weighted score, Allocate PLOS grade A-E. In addition, these instructions should be read alongside Table 3.36. Table 3.36 is an assessment sheet for the 11 components included in the model, arranged in order of relative relevance. In the zero-point column, the worst-case situation is defined. The following columns are 1, 2, 3 or 4 points, and the larger the scale, the higher the rate of "pedestrian friendly".

3.2.11. Traffitec Model

Jensen (2007), thinking that most of the existing PLOS methods will not be effective in Denmark and that most of them can only be used for existing sidewalks and walkways, he created a new method to be used especially in Denmark. Jensen (2007) created a pedestrian satisfaction model based on the cumulative logit regression of ratings provided by pedestrians and factors associated with satisfaction ratings. On a six-point scale, segments were rated as follows: very unsatisfied, moderately dissatisfied, somewhat dissatisfied, somewhat satisfied, moderately satisfied, and extremely satisfied.

In these analyzes conducted separately for pedestrians and cyclists, each participant was given a camera and asked to move on certain times and roads. Some of the original data acquired by watching video clips was omitted from the final versions because the road administrators and others who would apply the models lack the data in the required model. Not filtered out and included in newer models are the following significant variables connected with customer satisfaction ratings:

- Walking Direction
- Sounds distinct from road noise
- Weather
- Sidewalk quality

Satisfaction ratings and variables significantly associated with the original format and included in the final versions:

- Passed both vehicles and bicycles
- Passed pedestrians
- Passed parked cars

In the study, the primary purpose of data analysis was to determine the main independent variables that affect pedestrian satisfaction. CLM stepwise regression was used to identify all important effects, seek for significant square and interaction terms, and exclude insignificant variables. The response variable consists of six degrees of satisfaction, such as the number of responses that are very pleased. This generated model is a utility function based on each of these variables. Model which will be used in this study can be seen below.

$$logit(p) = \alpha \begin{bmatrix} very\ satisfied = -2.8526 \\ moderately\ satisfied = -1.2477 \\ a\ little\ satisfied = -0.0646 \\ a\ little\ dissatisfied = 0.8758 \\ moderately\ dissatisfied = 2.2543 \end{bmatrix} +$$

$$WA \begin{bmatrix} sidewalk - concrete\ flags = 3.5486 \\ sidewalk - asphalt = 1.9149 \\ bicycle\ path/track = 1.0124 \\ bikelane/paved\ shoulder = -2.8293 \\ driving\ lane = -3.6464 \end{bmatrix} + AREA \begin{bmatrix} residential = 0.4871 \\ shopping = 0.5385 \\ mixed = -1.6349 \\ rural\ fields = 1.2380 \\ rural\ forest = 0.5122 \end{bmatrix} -$$

$$0.002476 * MOT + 0.0000003364 * MOT^2 - 0.0303 * SPEED + 0.00002211 *$$

$$SPEED * MOT - 0.005432 * PED + 0.000005062 * PED^2 - 0.003772 * BIKE +$$

$$0.000003111 * BIKE^2 + 0.4408 * BUF - 0.0365 * BUF^2 - 0.05286 * PARK +$$

$$1.0180 * MED + 0.2938 * SB + 0.6277 * BL + 0.7380 * LANE + 0.3311 * TREE$$

(3.51)

Where,

$logit(p)$ = extensive logit model utility function,

α = intercept parameter of the satisfaction level response,

WA = type of walking area,

AREA = type of environmnet,

MOT = Motor vehicle quantities

SPEED = average vehicle speed (km/h),

PED = passed people per hour on the closest roadside while walking at 5 km/h.

BIKE = bicycles and motorized scooters per hour in either direction.

BUF = Width between the pedestrian area and the driving lane (meters),

PARK = number of parked vehicles per 100 meters,

MED = median dummy, median = 1, no median = 0

SB = walking area width, if this is a sidewalk or cycling path / track (meters)

BL = the overall width of the walking area as well as the adjacent driving lane, regardless of whether the walking space is a bike lane, paved side, or driving lane (meters),

LANE = driving lane dummy, four or more lanes or more = 1, one to three lanes or less = 0.

TREE = one or more trees every 50 meters on the road = 1, else 0

The PLOS criteria are based on dividing response satisfaction levels. Consistent with the Highway Capacity Manual, the following six LOS categories (A through F) are specified. A "democratic" aproach is used, that is, LOS is called A if 50 percent or more is very satisfied. LOS is referred to as B if 50 percent or more is very or moderately satisfied and less than 50 percent is very satisfied. And similarly, if 50 percent or more is not very satisfied, LOS will result in F.

4. CHAPTER

ANKARA REGIONS USED IN THIS STUDY

Ankara is the capital of Turkey and needs to be designed considering the pedestrian-vehicle relationship and pedestrian priority as other metropolitan cites. Therefore, for this thesis, ten different points in Ankara were selected in order to observe pedestrian activities and pedestrian service level degrees. Firstly, the observations made, the general profile of pedestrians and the current state of the existing roads were mentioned in this section. Then, eleven PLOS and one LOS methods used in the ten observed regions were examined with details. Observations made, difficulties encountered and data sets received were presented and the results were compared in this section.

4.1. Transportation by Walking in Ankara

"Determination of Vehicle and Pedestrian Road Service Levels and Investigation of Road Safety in Ankara Province Some Selected Regions" thesis study was carried out with the help of Ankara Metropolitan Municipality Traffic Monitoring Unit by obtaining three-week data between 19.07.2021 – 25.07.2021, 02.08.2021-08.08.2021 and 09.08.2021-15.08.2021. In the study, 3 selected regions were examined for 12 hours a day, and the results obtained were monitored with the help of cameras for 3 hours a day in the other 7 regions. In order for the research to give a safer result, long-term counts were made and a period of 1 week for the feast, 1 week after the feast and a period in which the bans were loosened even more in the pandemic were selected for these counts. Thus, improvement suggestions were given in the study as much as possible.

In addition to camera monitoring, when the pedestrian profile is tried to be taken into account with the visits and studies to selected regions, it has been noticed that people of all ages use Ankara's pedestrian roads, regardless of gender. When talking to the traffic experts of the municipality, it was noted that the vehicle-pedestrian density balances have changed considerably since the beginning of the pandemic, and there has been an increase in the number of pedestrians with the thought that private vehicles increased first and then it was effective in the economic reasons. Generally, many people prefer transportation by walking in Ankara. It is expected that the increase in pedestrians will be even more in the coming periods and the quality of pedestrian service will be more important.

4.2. Data Collection for Ankara

As mentioned in the previous chapters of the study, there were many methods for determining service levels, and of course, different types of data sets should be created for these methods. The data sets that need to be collected for 11 pedestrian service level methods and 1 vehicle road service level method that we have used in the study can be examined under three main headings as i) Pedestrian counts, ii) Pedestrian road infrastructure and environmental factors, and finally iii) Vehicle traffic counts.

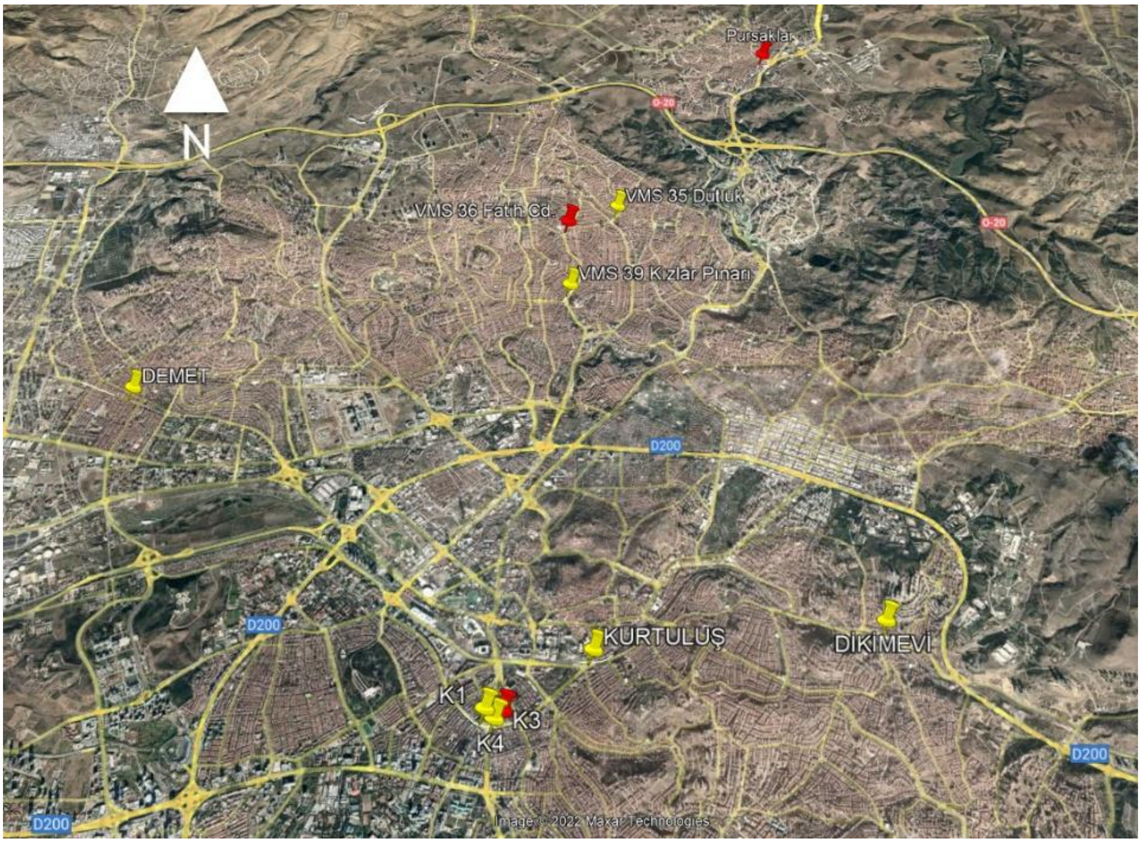

Figure 4.1. All selected regions in Ankara

4.2.1. Pedestrian Counts

In the 10 regions selected in this study, the selection was made from the densest and average-density populated regions of Ankara. Selected regions can be seen the in Figure 4.1, Figure 4.2 and Figure 4.3.

In order for obtainin more accurate results in the study, first of all, in the 3 regions marked with red on the figure; 12-hour counts were made between 07:30 in the morning and 19:30 in the evening and the 3 busiest hours of the day were determined. 7 regions marked with yellow, 3-hour counts were taken at 07:30 – 08:30 in the morning, 12:30 – 13:30 in the afternoon, and 17:30 – 18:30 in the evening. Each of the counts was taken as 3 minutes, 15 minutes and 1 hour in order to be more detailed.

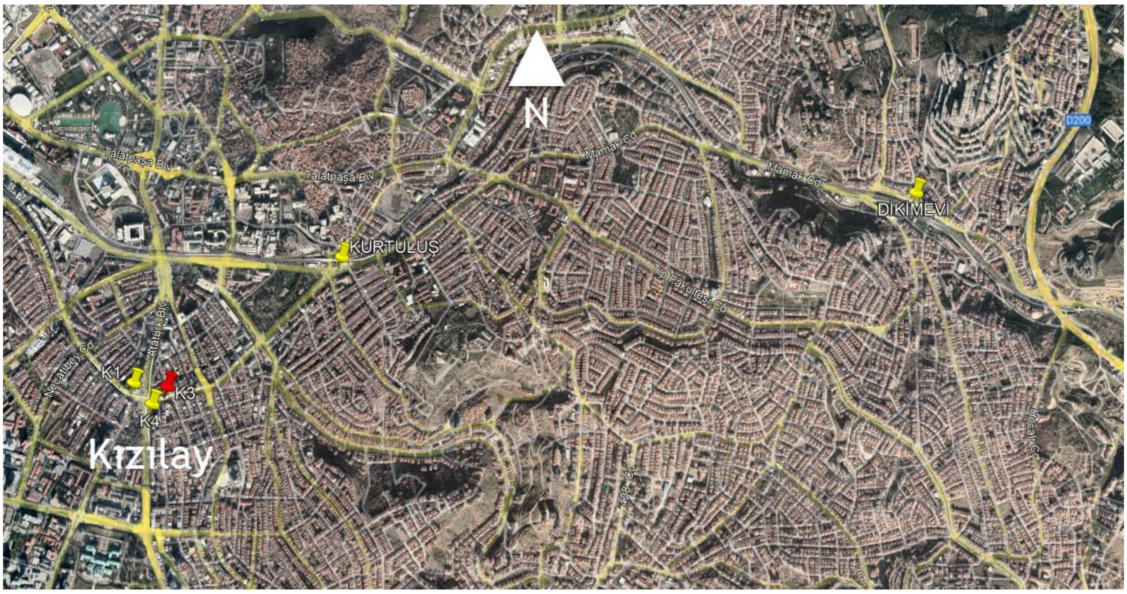

Figure 4.2. Representation of Kızılay (3 regions), Kurtuluş and Dikimevi regions on the map

The study was carried out in a 3-week period between 19.07.2021-25.07.2021 and 02.08.2021-15.08.2021. As expected in the counting areas, a business traffic was observed especially in the morning and evening counts on weekdays, and it was noticed that there was a high level traffic jam during the lunch hour.

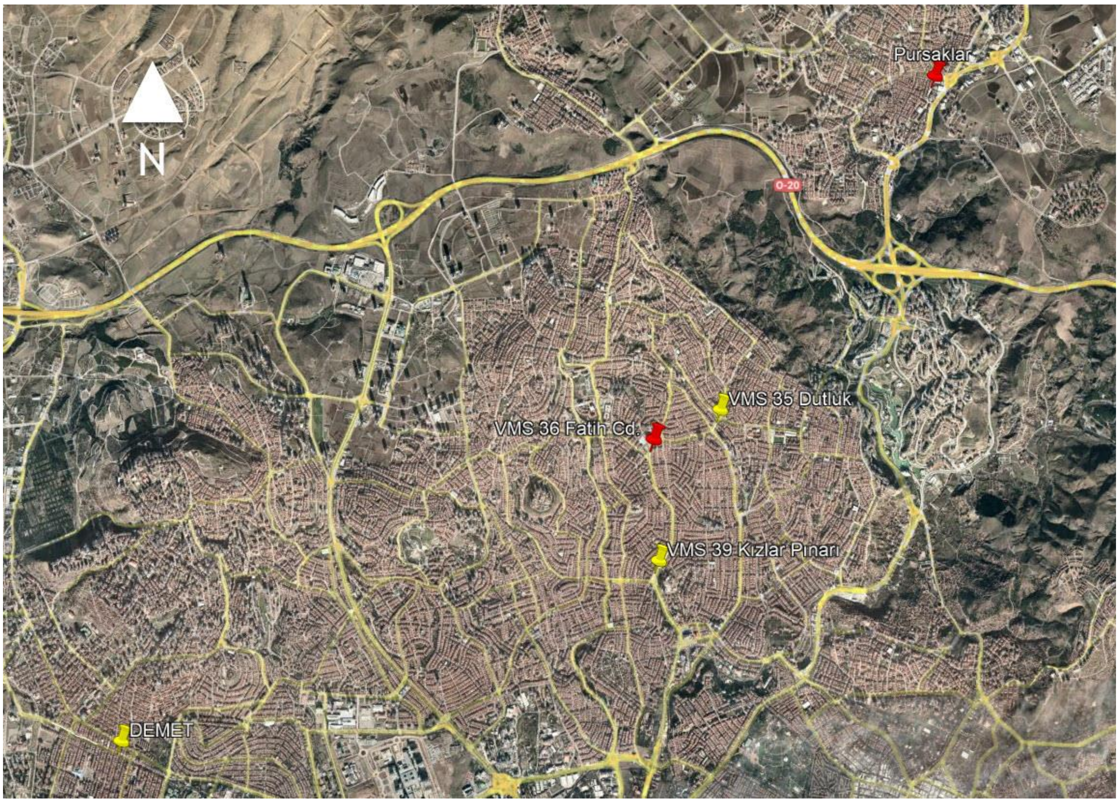

Figure 4.3. Representation of Dutluk, Keçiören, Kızlar Pınarı, Demet, Pursaklar regions on the map

According to the observations made in the counted regions, no traffic flow in a certain direction was noticed in any region. As there is no right-left distinction on the sidewalks, it has been noticed that every part of each sidewalk examined is used in two directions. Although it was desired to distinguish between men and women in the counts made on the camera at the beginning of the work, it was decided to make the gender discrimination to be made by directly observing the road users. However, when this examination is made by going to the regions, almost half of the pedestrian road users have been identified in each region without any gender discrimination. A count data sheet form was created to complete the counts, and on this form, as far as can be understood from the camera records, pedestrians were divided into two parts and recorded as individuals with disabilities and individuals without disabilities.

4.2.2. Infrastructure Data and Environmental Effect

It is an undeniable fact that the quality of the sidewalk infrastructure affects the service level of the pedestrian path. Almost every PLOS method that has taken its place in the literature takes into account the infrastructure quality of infrastructure pedestrian roads. Environmental and psychological factors have also started to take their place in PLOS methods with different studies carried out. Although mathematical equations have not been developed to determine the optimal comfort levels pedestrians seek, environmental psychologists' surveys and studies indicate that a comfortable setting enhances the walking experience. In the majority of situations, comfort is a factor in deciding the distance walked. (Sarkar, 2002)

While creating the data set of infrastructure and environmental factors, a form was prepared and thanks to the special permission obtained from the municipality each of the regions was visited by 2 people. Necessary measurements were mostly provided with the help of meters. For methods such as trip quality, the observations of 2 people were noted separately, and their opinions were obtained by asking questions to the users using the pedestrian path in the vicinity. Likewise, Ankara Metropolitan Municipality Traffic Experts, who played a major role in creating the data set of the study, were consulted on certain issues and the information received was processed.

The main data taken for the creation of this data set can be sorted as; sidewalk width, sidewalk quality, presence of median, presence of trees, number of connections to the pedestrian path used, shaded areas, rest areas, facilities provided for the disabled, existence and types of bus stops, presence of buffer separating pedestrian and vehicle roads, function and aesthetics of surrounding buildings. Additionally, there were many other factors such as sound factors. These factors include; sidewalk ramps, toilets in the vicinity, overpass or underpass, signal for crossing, slope of the pedestrian road, airline conditions, air pollution, obstacles on the pedestrian path. Since there were differences between the methods, no method has looked at every determined factor in itself.

While completing the necessary infrastructure measurements of the 11 pedestrian road service level methods to be implemented, many problems were encountered. Since the pedestrian flow could not be stopped during the measurements, some difficulties were encountered in the measurements made with meters.

Even though drainage was not specifically mentioned among the methods and no bad weather conditions were encountered during the observation period, it is known that water problems were particularly evident in the frequently used areas of Ankara. Especially the sidewalk in the Kızılay region has the water problem. The accumulated water leaks down from the sidewalk cracks and joint areas and stays under the paving stones until it completes the absorption and evaporation phase, and when people step on them due to their weak connections, the water under them squirts with upward pressure.

In order to preserve the integrity of the study and to make the regions easier to understand, names from A1 to A10 were given as a symbol for each region. Each region's symbol, camera name and region name can be seen in Table 4.1. In addition, geometric measurements of each region taken in the field were given in Table 4.2.

Table 4.1. Symbols of Counted Regions

Symbol	**Region**	**Camera Name**
A1	Kızılay	K1
A2	Kızılay	K2
A3	Kızılay	K3
A4	Dutluk	VMS35
A5	Keçiören	VMS36
A6	Kızlar Pınarı	VMS39
A7	Demet	Demet
A8	Kurtuluş	Kurtulus
A9	Pursaklar	Pursaklar
A10	Dikimevi	Dikimevi

Table 4.2. Geometric Measurements of Regions

Property	Number of Lanes	Lane Width (cm)	Slope (%)	Walkway Width (cm)	Effective Walkway Width (cm)	Lateral Clearance (cm)	
						Right	Left
A1	2	330	4	850	550	90	30
A2	2	320	-3	370	300	190	30
A3	4	350	-2	1830	820	40	50
A4	2	350	3	250	160	0	40
A5	2	380	-5	420	220	Parking	40
A6	3	335	-3	610	360	80	35
A7	2	360	-3	395	70	Parking	35
A8	3	330	4	975 (Ave)	665	50	30
A9	1-1	270	-4	225	210	Parking	0
A10	2	340	1	420	110	30	30

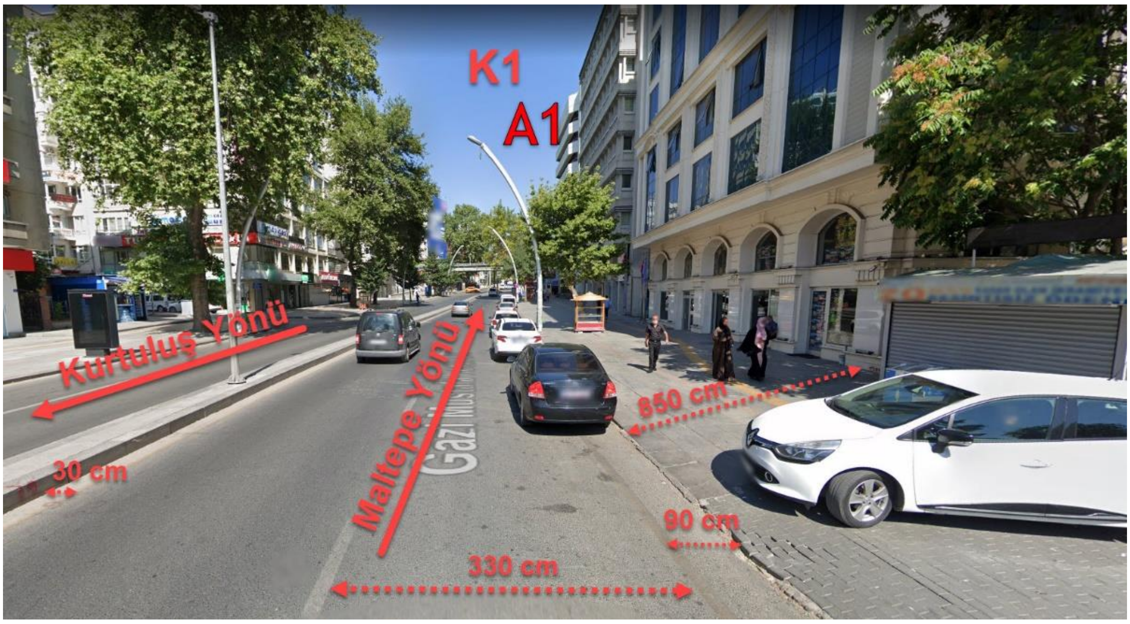

Figure 4.4. A1 Region Measurement Display

Table 4.3. A1 Region properties

Property	**Level**	**Property**	**Level**
Enclosure	Good	Stopping Places	Very poor
Connectivity	Good	Protection from weather conditions	Poor
Building Articulation	Moderate	Noise levels	Poor
Transpearency	Good	Physical Effort	Poor
Buffer	Moderate	Lighting	Very good
Shade Trees	Poor	Surface Quality	Very poor
Overhangs	Good	Support for disabled people	Very poor
Facilities	Good	Personal security	Poor

When the A1 region is examined, it has been observed that although tactile sidewalk is used for the disabled in some parts, it and the general quality of the sidewalk were in a very bad condition. In addition, it has been observed that narrowing occurs on the sidewalk as we move on in the selected segment. A1 Kızılay region's geometric properties were shown in Figure 4.4 and detailed quality properties can be seen in Table 4.3. During the studies, it was observed that tactile sidewalk is not existed for some of the segment's parts and for the parts that tactile sidewalk presents Figure 4.5 was shared as an example in order to show the bad quality.

Figure 4.5. Existing Tactile Sidewalk of A1 region

While the A2 was observed, the density of people using the pedestrian road and the tactile sidewalks made for the disabled attracted attention. In addition to these, it has been observed during the studies that the quality of the sidewalk is in a very bad condition. Measurements of the A2 region were shared in Figure 4.6 and the properties of the region can be seen in Table 4.4.

Figure 4.6. A2 Region Measurement Display

Table 4.4. A2 Region properties

Property	Level	Property	Level
Enclosure	Moderate	Stopping Places	Very poor
Connectivity	Very good	Protection from weather conditions	Poor
Building Articulation	Moderate	Noise levels	Very poor
Transpearency	Good	Physical Effort	Poor
Buffer	Poor	Lighting	Moderate
Shade Trees	Very poor	Surface Quality	Very poor
Overhangs	Good	Support for disabled people	Very poor
Facilities	Good	Personal security	Poor

Measurements of the A3 region were shared in Figure 4.7 and the properties of the region can be seen in Table 4.5.

Figure 4.7. A3 Region Measurement Display

Table 4.5. A3 Region properties

Property	**Level**	**Property**	**Level**
Enclosure	Moderate	Stopping Places	Poor
Connectivity	Good	Protection from weather conditions	Moderate
Building Articulation	Moderate	Noise levels	Very poor
Transpearency	Good	Physical Effort	Poor
Buffer	Moderate	Lighting	Very good
Shade Trees	Poor	Surface Quality	Very poor
Overhangs	Moderate	Support for disabled people	Poor
Facilities	Good	Personal security	Poor

When the A4 region was examined, it has been determined that the sidewalk does not continue in a regular width and the quality is in a very bad condition. It was also observed that there were obstacles dividing the road in two on the narrowing sidewalk. Measurement display of the A4 region is shared in Figure 4.8 and the properties of the region can be seen in Table 4.6.

Figure 4.8. A4 Region Measurement Display

Table 4.6. A4 Region properties

Property	**Level**	**Property**	**Level**
Enclosure	Very poor	Stopping Places	Very poor
Connectivity	Poor	Protection from weather conditions	Moderate
Building Articulation	Very poor	Noise levels	Poor
Transpearency	Poor	Physical Effort	Poor
Buffer	Good	Lighting	Moderate
Shade Trees	Moderate	Surface Quality	Very poor
Overhangs	Moderate	Support for disabled people	Very poor
Facilities	Poor	Personal security	Poor

Although a wide sidewalk is observed at first glance, the obstacles on the sidewalk along the road, poor sidewalk quality, lack of support for the disabled, and even the obligation to walk the pedestrians on the unpaved road in some areas were noted in the A5 field study. Measurements of the A5 region were shared in Figure 4.9 and the properties of the region can be seen in Table 4.7.

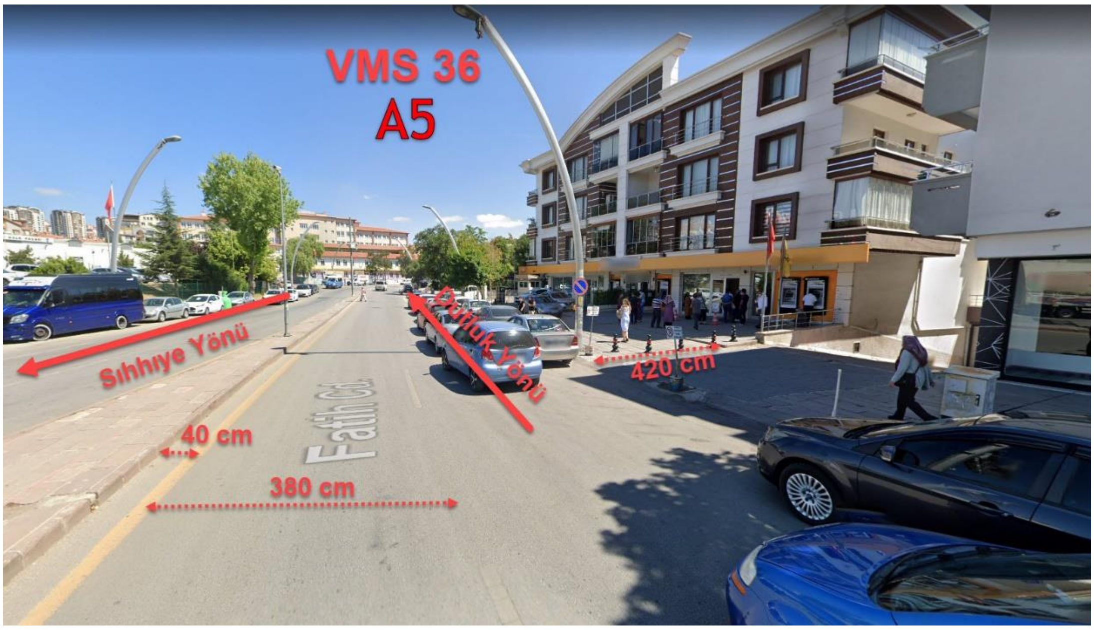

Figure 4.9. A5 Region Measurement Display

Table 4.7. A5 Region properties

Property	**Level**	**Property**	**Level**
Enclosure	Poor	Stopping Places	Very poor
Connectivity	Poor	Protection from weather conditions	Very poor
Building Articulation	Moderate	Noise levels	Moderate
Transpearency	Poor	Physical Effort	Poor
Buffer	Moderate	Lighting	Moderate
Shade Trees	Very poor	Surface Quality	Very poor
Overhangs	Poor	Support for disabled people	Very poor
Facilities	Poor	Personal security	Good

When the A6 region was examined, a high level of deterioration in sidewalk quality was observed. Apart from this, the poor quality of the curb ramps built in the region was built in a way that could be harmful, on the contrary, to support people with disabilities. As can be seen on site, it was noticed that the sidewalk was expanded after an improvement work was carried out. Measurement display of the A6 region is shared in Figure 4.10 and the properties of the region can be seen in Table 4.8.

Figure 4.10. A6 Region Measurement Display

Table 4.8. A6 Region properties

Property	**Level**	**Property**	**Level**
Enclosure	Poor	Stopping Places	Very poor
Connectivity	Moderate	Protection from weather conditions	Poor
Building Articulation	Poor	Noise levels	Moderate
Transpearency	Poor	Physical Effort	Moderate
Buffer	Moderate	Lighting	Moderate
Shade Trees	Moderate	Surface Quality	Very poor
Overhangs	Moderate	Support for disabled people	Very poor
Facilities	Moderate	Personal security	Poor

As a result of the studies carried out in the A7 Demet region, although it was seen that the region has a reasonable level of sidewalk quality and good quality resting areas, it has been noticed that the region is quite lacking for disabled individuals. Measurements of the A7 region were shared in Figure 4.11 and the properties of the region can be seen in Table 4.9.

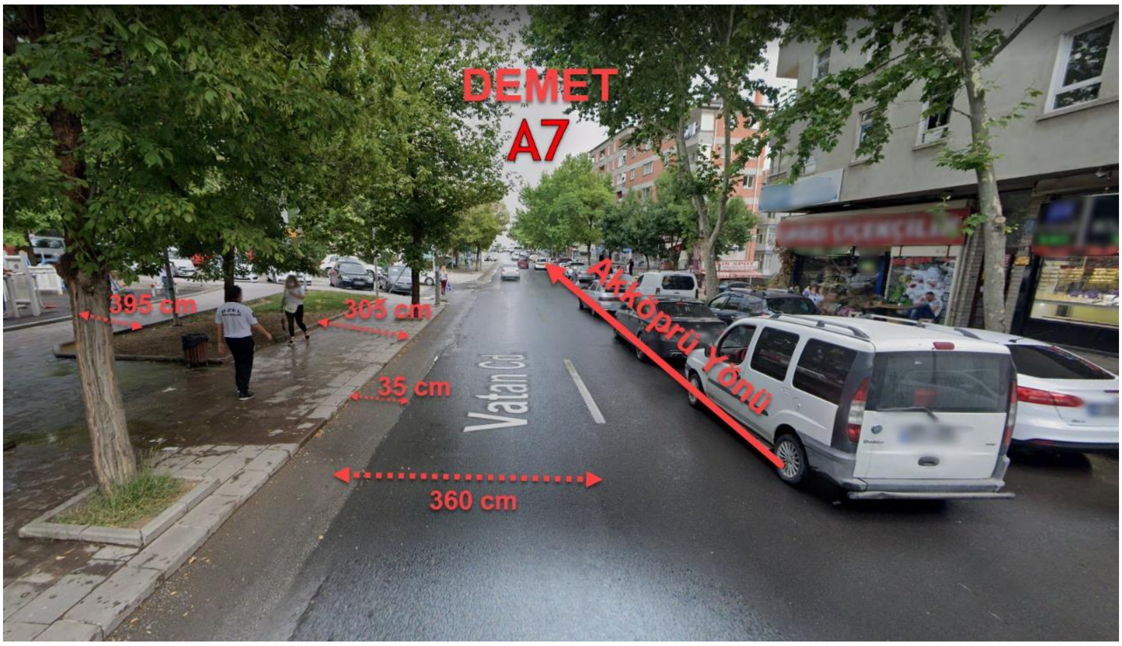

Figure 4.11. A7 Region Measurement Display

Table 4.9. A7 Region properties

Property	**Level**	**Property**	**Level**
Enclosure	Moderate	Stopping Places	Good
Connectivity	Moderate	Protection from weather conditions	Moderate
Building Articulation	Poor	Noise levels	Moderate
Transpearency	Moderate	Physical Effort	Moderate
Buffer	Very good	Lighting	Very good
Shade Trees	Very good	Surface Quality	Moderate
Overhangs	Good	Support for disabled people	Poor
Facilities	Moderate	Personal security	Moderate

As a result of the studies carried out in the region, besides the poor quality of the sidewalk, as in most places, there was a lack of a pedestrian path suitable for disabled individuals. Measurement display of the A8 region is shared in Figure 4.12 and the properties of the region can be seen in Table 4.10.

Figure 4.12. A8 Region Measurement Display

Table 4.10. A8 Region properties

Property	Level	Property	Level
Enclosure	Good	Stopping Places	Very good
Connectivity	Moderate	Protection from weather conditions	Poor
Building Articulation	Moderate	Noise levels	Moderate
Transpearency	Moderate	Physical Effort	Very good
Buffer	Very Poor	Lighting	Moderate
Shade Trees	Poor	Surface Quality	Very poor
Overhangs	Very Poor	Support for disabled people	Moderate
Facilities	Poor	Personal security	Moderate

Observations in the A9 region have shown that people were also prone to non-sidewalk road use, and the sidewalk quality and the quality of the ramps were quite poor. Measurements of the A9 region were shared in Figure 4.13 and the properties of the region can be seen in Table 4.11.

Figure 4.13. A9 Region Measurement Display

Table 4.11. A9 Region properties

Property	**Level**	**Property**	**Level**
Enclosure	Poor	Stopping Places	Very poor
Connectivity	Moderate	Protection from weather conditions	Poor
Building Articulation	Poor	Noise levels	Poor
Transpearency	Moderate	Physical Effort	Poor
Buffer	Moderate	Lighting	Poor
Shade Trees	Moderate	Surface Quality	Very poor
Overhangs	Poor	Support for disabled people	Very poor
Facilities	Poor	Personal security	Poor

In A10 region, it is observed that there is a very large green area that separates the sidewalk, as same in the A7 region. Studies carried out in A10 region have drawn attention to the fact that this region is average in terms of many factors, but there were very narrow parst on the sidewalk, especially near the vehicle road. Measurement display of the A10 region is shared in Figure 4.14 and the properties of the region can be seen in Table 4.12.

Figure 4.14. A10 Region Measurement Display

Table 4.12. A10 Region properties

Property	Level	Property	Level
Enclosure	Good	Stopping Places	Moderate
Connectivity	Moderate	Protection from weather conditions	Moderate
Building Articulation	Poor	Noise levels	Poor
Transpearency	Moderate	Physical Effort	Moderate
Buffer	Very poor	Lighting	Very good
Shade Trees	Moderate	Surface Quality	Moderate
Overhangs	Moderate	Support for disabled people	Poor
Facilities	Good	Personal security	Moderate

4.2.3. Vehicular Data

In order to measure vehicle usage in selected regions, just as in pedestrian measurements, measurements were made by camera images for same times with the help of the Ankara Metropolitan Municipality Traffic Monitoring Department. While collecting vehicle statistics, the vehicles used were divided into 6 categories and while counting the cameras on the form, they were coded into certain numbers and noted. We can list these 6 vehicle categories such as personal vehicles, trucks, buses and minibuses, big trucks and caravans, motorcycles, bicycles and scooters. LOS values were calculated for each counted hour by considering the vehicle road adjacent to the pedestrian path in each selected region. The result was obtained by using the vehicle LOS values calculated at the required points for the pedestrian LOS methods in the Equations 3.1, 3.4, 3.9.

According to the observations, traffic jams were frequently experienced especially in the Kızılay region. Since the 10 selected regions were Ankara inner-city regions, 50 km/h has been taken as the speed limit, but it has been observed that vehicles violate this speed rule when there is no traffic jam. According to the results obtained, although the vehicle LOS value appears to be F almost every hour for each selected region in the Ankara region, exceptional cases have been experienced and better values than F have been observed.

5. CHAPTER

RESULTS

5.1. LOS and PLOS Analysis

In this part, the results of LOS and PLOS values can be seen for ten different regions in Ankara. 1 LOS and 11 PLOS methods were studied with all the collected data. The result tables were examined in detail in this analysis section and compared with each other. It can be seen both vehicle and pedestrian traffic in each selected region.

The number of vehicle and pedestrian were counted in the Ankara Metropolitan Municipality Traffic Monitoring Department by using camera screen videos. As mentioned before, for the 10 selected regions, a total of 756 hours of counting was made for 3 weeks, 21 days and 12 hours in 3 different regions (A2, A6, A9) in order to find effective times. Then, for the determined peak hours, a total of 441 hours were counted for 3 weeks, 21 days and 3 hours in the other 7 regions (A1, A3, A4, A5, A7, A8, A10), and a total of 1197 hours were counted for 10 different regions (A1-A10). Since peak hours show themselves more on weekdays, calculations were made over the same hours for the weekends.

5.1.1. HCM Vehicular LOS Results

Vehicle counts were the most basic requirement for a LOS calculation in accordance with the HCM method. After the hourly counts were made, the 15-minute periods showing the highest number of vehicles for each hour were determined and the peak hour factor values were calculated. In each region, vehicles were counted in 5 different categories as private cars, motorcycles, bus, minibus and recreational vehicles values were determined in accordance with the HCM method and converted into percentages. The road slope of the examined segment was determined and this slope value with the Car Equivalent values were found from the Table 3.5, Table 3.6, Table 3.7, Table 3.11. Afterwards the heavy vehicle factor was calculated with the help of the Equation. By checking the access points on the road, the adjustment factor was found from the Table 3.4 and placed in the Equation 3.2. Apart from these, the flow rates of the selected regions were calculated by measuring the road lane widths, lateral clearance and shoulder width. After examination of the calculated flow rates, LOS values were determined for each region.

Excluding rare exceptions for all regions, better LOS results than “E” and “F” values were not observed for Ankara in general. For three weeks between 19.07.2021-15.08.2021, vehicular LOS Results for three different regions (A2, A5, A9) by using HCM method can be observed in Table 5.1, Table 5.2 and Table 5.3 and for peak hours HCM results for seven regions (A1, A3, A4, A6, A7, A8, A10) can be seen at Table 5.4. First week was holiday week for Turkey, so in the morning hours, especially for A5 (Kecioren), traffic jam is at low levels (C), but for other hours traffic is at high levels and LOS degree is approximately F. However, other crowded areas for population LOS degree is almost F for all times. But, other weeks were working days, and so all areas have F degree for LOS. Therefore, for all roads new improvement techniques should be used and traffic jam should be decreased. Thus, at the end of the chapter some improvement discussions were made for selected areas.

In this study, A1 Kızılay region was chosen to give an example of how multilane gihhway vehicle LOS values were calculated. Constant values that were independent of date and time were taken as follows;

Since the posted speed is 50 km/h on Ankara city roads, by adding 11 km/h to the posted speed, it has been taken as $BFFS = 61\ km/h$. Since the investigated A1 region is a divided Multilane Highway, it is taken as $fm = 0$. Lane width of the region was measured as $W = 3.3\ m$ and with this value used in the Table 3.1 $flw = 3.1$ is found. The number of road lanes was taken as $N = 2$ nd since the lateral clearances were measured as $Lcr = 0.9\ m\ \&\ Lcl = 0.3$ Equation 3.3 was used to find $Tlc = 1.2\ m$. Table 3.2. is used with the obtained TLC value and $flc = 3.0$ value is obtained. As a result of the research done in the field for the segment, it was found that $Access\ Point = 6$ and by using this value in Table 3.4. $fa = 4$ was obtained.

With the obtained values, $FFS = 51\ km/h$ value was reached by using Equation 3.12. The driver population factor value shows the percentage of the local-drivers using the route. This value is usually taken between 0.9 and 1 in HCM method analysis. For A1 region driver population factor value, weekday and weekend values were taken as $fp = 0.98\ (Weekday)$, $fp = 0.93\ (Weekend)$ respectively. The slope of the road was found to be $Slope = 4\ \%$ with the data obtained.

When the date of 19 July 2021 is examined between 8:30 and 9:30, it is observed that the total number of vehicles per hour is $V = 562$ and the number of vehicles passing by the road in the highest 15-minute period is found to be $V15 = 162$. The peak hour factor was calculated with the data obtained, and the value of $PHF = 0.867$ was reached. Then, in order to find the heavy vehicle factor, $Pt = 12\ \%$ & $Pr = 0\ \%$ values were reached by looking at the percentages of trucks, buses, minibuses, trucks and RVs during this hour. By using these percentage values and road slope, passanger car equivalent values were calculated as $Et = 1.5$ & $Er = 0$ with the help of the table. Then, the values obtained were used in the Equation 3.4 and the value of $Vp = 2314.286\ pc/h/ln$ was reached. Then, by using the Equation 3.11, the vehicle density was found as $D = 45.378\ pc/km/ln$ the intervals in the graph were checked, and the LOS value of the segment was found to be “F” at this date and time.

For only A9 region, since the road type is of 2-lane highway, both of the directions on road was counted. Class II type two-lane highway was chosen for this region. Class II, according to HCM, is generally a two-lane highway serves relatively short journeys, and drivers do not necessarily expect to travel at high speeds. Routes can pass through rough terrain. Travel speeds were generally lower than Class I highways, typically assigned to Class II. While calculating LOS for Class II type two-lane highways, Percent time spent following is calculated by the Equation 3.9.

Since A9 region is also an Ankara city road same as multilane highway $BFFS = 61\ km/h$ was taken to calculate Free Flow Speed. As a result of the research done in the field, it was found that there were 10 driveway access point on this segment. By using this value in Table 3.4. $fa = 6.67$ was obtained. Due to having $W = 2.7\ m$ lane width and $f_{lc} = 0\,m$ shoulder width by using the Table 3.8 adjustment factor for lane and shoulder witdh $f_{LW} = 10.3$ was found. With the help of the Equation 3.7 free flow speed $FFS = 44\,km/h$ was obtained. When the hourly counts were examined, it has been determined that the number of heavy vehicles using the region does not exceed 100 per hour. According to the observations done for this region terrain type was taken as Rolling Terrain. Since, only PTSF calculation is needed in this study, $Et = 1.9$ & $Er = 1$ values were taken from Table 3.10. Directional split for the highway of A9 was accepted as 50/50 for the calculations. No passing zone percentage of the roadway was observed as approximately 80%.

When examining the 17:30 – 18:30 hours on 25.07.2021, hourly flow rates were determined in both directions to find the 15-min passenger car equivalent flow rate. According to the results obtained from the counts, the flow rates of the first direction, whose sidewalk we have also examined, and the opposite lane, were found as $V_d = 427\,veh/h$ & $V_o = 421\,veh/h$ respectively. Peak Hour Factors were also calculated in accordance with the Equation 3.5 and found to be $PHF_d = 0.88$ & $PHF_o = 0.94$ respectively for the first direction and for the opposite direction. Percentages of trucks were found as $Pt_d = 11\ \%$ and $Pt_o = 14\ \%$ from the countings. For both of the direction recreational vehicle percantages were found as 0%. Using the Equation 3.6 $f_{HVd} = 0.091$ & $f_{HVo} = 0.074$ heavy vehicle factor adjustments were obtained. Grade adjustment factors were taken from the Table 3.9 as $f_{Gd} = 0.92$ & $f_{Go} = 0.91$. By using the Equation 3.8, 15-min passenger car equivalent flow rates were found $v_d = 5758\,pc/h/ln$ & $v_o = 6676\,pc/h/ln$ respectively.

No passing zone adjustment factor was taken $f_{np} = 5.7$ from the Table 3.11. To determine the base percent time spent following PTSF coefficient were taken as $a = -0.0062$ & $b = 0.817$ from Table 3.12. By using the Equation 3.10 $BTSF = 99.93$ was obtaioned. $PTSF = 102.57$ was found as a result of the Equation 3.9. Since PTSF value is above 85, LOS grade was found as “E” from Table 3.13.

Table 5.1. HCM Vehicular LOS 1st Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
19.07.2021	**A2**	F	F	F	F	F	F	F	E	F	F	F	E
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
20.07.2021	**A2**	E	F	F	F	F	F	F	F	E	F	F	F
	A5	C	D	F	F	F	F	F	F	E	E	F	E
	A9	E	E	E	E	E	E	E	E	E	E	E	E
21.07.2021	**A2**	E	F	F	E	F	F	F	F	F	F	F	F
	A5	B	E	F	F	E	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
22.07.2021	**A2**	F	F	F	F	F	F	F	F	F	F	F	F
	A5	C	F	F	E	F	F	F	F	F	F	F	E
	A9	E	E	E	E	E	E	E	E	E	E	E	E
23.07.2021	**A2**	C	D	C	C	C	F	F	F	F	E	F	F
	A5	F	F	F	F	F	F	F	F	F	F	E	E
	A9	E	E	E	E	E	E	E	E	E	E	E	E
24.07.2021	**A2**	E	F	F	F	F	F	F	F	F	F	F	F
	A5	D	D	E	E	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
25.07.2021	**A2**	F	F	F	F	F	F	F	F	F	F	F	F
	A5	D	F	E	F	F	F	F	E	E	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E

Table 5.2. HCM Vehicular LOS 2nd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
02.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
03.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
04.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
05.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
06.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
07.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
08.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E

Table 5.3. HCM Vehicular LOS 2nd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
09.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
10.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
11.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
12.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
13.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
14.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E
15.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	E	E	E	E	E	E	E	E	E	E	E	E

Table 5.4. Vehicular LOS Results by HCM of peak hours for 19.07.2021-15.08.2021

Time	Region	Hour Intervals			Time	Region	Hour Intervals			Time	Region	Hour Intervals		
		8:30 - 9:30	12:30 - 13:30	17:30 - 18:30			8:30 - 9:30	12:30 - 13:30	17:30 - 18:30			8:30 - 9:30	12:30 - 13:30	17:30 - 18:30
19.07.2021	**A1**	F	F	F	**02.08.2021**	**A1**	F	F	F	**09.08.2021**	**A1**	F	F	F
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	E	-	F		**A4**	F	F	F		**A4**	F	F	F
	A6	F	F	F		**A6**	F	F	F		**A6**	F	F	F
	A7	F	F	F		**A7**	F	F	F		**A7**	F	F	F
	A8	F	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F
20.07.2021	**A1**	C	E	E	**03.08.2021**	**A1**	F	D	D	**10.08.2021**	**A1**	F	F	F
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	E	F	F		**A6**	F	F	F		**A6**	F	F	F
	A7	F	F	F		**A7**	F	F	F		**A7**	F	F	F
	A8	E	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	D		**A10**	F	F	F		**A10**	F	F	F
21.07.2021	**A1**	D	C	F	**04.08.2021**	**A1**	F	F	F	**11.08.2021**	**A1**	F	F	F
	A3	E	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	E	E	F		**A6**	F	F	-		**A6**	F	F	F
	A7	F	F	F		**A7**	F	F	F		**A7**	F	F	F
	A8	E	E	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	-		**A10**	F	F	F
22.07.2021	**A1**	F	E	F	**05.08.2021**	**A1**	F	F	F	**12.08.2021**	**A1**	F	F	F
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	F	E	F		**A6**	F	F	F		**A6**	F	F	F
	A7	F	F	F		**A7**	F	F	F		**A7**	F	F	F
	A8	E	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F
23.07.2021	**A1**	E	E	F	**06.08.2021**	**A1**	F	F	F	**13.08.2021**	**A1**	F	F	F
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	F	F	F		**A6**	F	F	F		**A6**	F	F	F
	A7	F	F	F		**A7**	F	F	F		**A7**	F	F	F
	A8	E	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F

24.07.2021	**A1**	F	E	E	07.08.2021	**A1**	F	F	F	14.08.2021	**A1**	F	F	F
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	F	F	E		**A6**	F	F	F		**A6**	F	F	F
	A7	F	F	F		**A7**	F	F	F		**A7**	F	F	F
	A8	F	E	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F
25.07.2021	**A1**	F	D	E	08.08.2021	**A1**	F	F	F	15.08.2021	**A1**	F	F	F
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	F	F	F		**A6**	F	F	F		**A6**	F	F	F
	A7	F	F	F		**A7**	F	F	F		**A7**	F	F	F
	A8	F	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F

Since the first week is holiday week in Turkey, mostly in the morning hours, higher values than F level were observed in the regions. To be specific, until 12:30, LOS levels were observed to be C level in the A2 region on 23.07.2021, except 8:30 – 9:30 (D level). In the A5 region, it was observed that LOS was level C between 7:30 and 8:30 in the morning on 20.07.2021 Tuesday and 22.07.2021 Thursday. At the weekend of the first week, lower LOS levels were observed for the A2 and A5 regions in the morning hours compared to the weekdays. It has been observed that the hour intervals observed as B, C and D levels on weekdays were D, E and F levels on weekends. In the A2, A5 and A9 regions, where the 12-hour counts were made, no better results were observed than the E and F levels, except for the first week.

Similar to other 3 regions, A1, A3, A4, A6, A7, A8 and A10, where the 3-hour counts were examined, no better LOS grade than F level was observed in any region except for the A1 region. In the 1st week, on 20.07.2021, between 8:30 – 9:30 in the morning and between 21.07.2021 12:30 – 13:30, C level results were observed. When the results of the first week were examined, except for region A7, even the difference occurs for 1-hour, levels higher than the F level were observed, in all regions where 3-hour counts were made. In the A4, A6, A8 regions, E level results were found. 1 time for A4, 5 times for A6 and 6 times for A8, E results were observed. Other results of these regions were observed as F level. In the A10 region, for one time only D level were observed between 17:30 and 18:30 on 20.07.2021, other results of the region were found to be at F level. In the results of the 2nd week, after 12:30 on Tuesday, 03.08.2021, it was observed that there was a decrease in vehicle levels in the A1 region. And, it was noticed that the LOS levels were D at that time. Other than this exception, all results were observed to be at F level.

When the vehicle LOS results were examined in detail, it was observed that all results were at the worst levels, except for the 1st week and exceptional cases. The only region that results were observed different than F and E levels at the 2nd week was found to be A1. In Table 5.5, it was observed that other Kızılay regions (A2, A3) were found to be F level in this time period. This situation was considered as an exception, since no results other than F level were observed in the 2nd and 3rd week results on other days. Among the 10 regions, there was no region that could be called the better or worse than others.

Table 5.5. HCM Vehicle LOS Results on 03.08.2021

Time	**Region**									
03.08.2021	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
08:30 - 09:30	F	F	F	F	F	F	F	F	E	F
12:30 - 13:30	D	F	F	F	F	F	F	F	E	F
17:30 - 18:30	D	F	F	F	F	F	F	F	E	F

5.1.2. HCM Pedestrian LOS Results

Since peak hours show themselves more on weekdays, calculations were made over the same hours for the weekend. After the hourly counts, the 15-minute peak flow rates, which show the highest number of pedestrians for each hour, were determined by using the Equation 3.12. Then, in field measurements, the effective sidewalk width was found by measuring the width of the sidewalk, the dimensions of trees and similar obstacles with the help of meters. Thanks to these two values, hourly PLOS values were compared with the classification values specified in HCM, and A was named as the best and F as the worst.

The results of the HCM PLOS method were shared in Table 5.6, Table 5.7, Table 5.8 and Table 5.9. When the results were examined, it was observed that almost every hour of every region had a class A PLOS value. Even if people were walking on the road in partial areas, it has been taken into account and a conclusion has been made accordingly. These results have shown us that the result can be obtained with the HCM method even in regions that were not considered to be good levels by the public. Since each region averaged A while making the comparison, the study continued by considering the lowest PLOS values exhibited by the regions in the worst cases.

In the study, the A2 region was chosen to show an example of the HCM pedestrian road service level assessment. Fixed values regardless of the selected date and time; The sidewalk width is taken as $W = 3.7\ m$ and the effective sadewalk width is taken as $We = 3.0\ m$. When examination was made between 17:30 and 18:30 on August 9, 2021, the total number of pedestrians in the 15-minute period with the highest pedestrian crossing was observed as $pedV15 = 803\ p/15 - min$. Then, when this value is used with the effective sidewalk width in the Equation 3.12, $pedv_p =\ 18\ p/min/m$ was calculated and $v/c\ Ratio = 0.24$ was reached. When these values were examined in the Table 3.14, it gives us the value of “B” for this segment.

Except for the A7 (Demet) area, where narrowings occur in the pedestrian path, it was determined that the PLOS level was “A” in almost all of the other regions. Since the pedestrian level of service is evaluated in the same way as the vehicles according to the HCM method, it has been determined that the PLOS degree is found only by calculating the number of people per square meter. Since the effective sidewalk width decreases to 0.7 meters in the A7 region, a decrease was observed in PLOS to E level in this region. Apart from A7 region, it has been observed that the PLOS level remains A, unless number of pedestrians were observed at extreme levels. As shown in the example calculation for the HCM PLOS method, in only A2 (Kızılay) region, “B” level is encountered at some hours due to the very high number of pedestrians. During the holiday week, between 17:30 and 18:30 on 19.07.2021, when the PLOS value of the A7 region was found as E level, all other regions were found to be A level in this time period. Between 12:30 and 13:30 on 13.08.2021, when the A2 region was observed as B level, the A7 region was also observed as B level. When the results of the last week were examined, it was observed that the A7 region was found to be at a lower level (C, D) than in the morning hours (A, B). When A2 was examined in the same time period, it was observed that the PLOS level of the region was B.

Table 5.6. HCM Pedestrian PLOS 1st Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
19.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
20.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
21.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
22.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
23.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
24.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
25.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A

Table 5.7. HCM Pedestrian PLOS 2nd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
02.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
03.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
04.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
05.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
06.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
07.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
08.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A

Table 5.8. HCM Pedestrian PLOS 3rd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
09.08.2021	**A2**	A	A	A	A	A	A	A	A	A	B	B	B
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
10.08.2021	**A2**	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
11.08.2021	**A2**	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
12.08.2021	**A2**	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
13.08.2021	**A2**	A	A	A	A	A	B	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
14.08.2021	**A2**	A	A	A	A	A	A	A	A	A	A	B	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
15.08.2021	**A2**	A	A	A	A	A	A	A	A	A	A	B	B
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A

Table 5.9. PLOS Results by HCM of peak hours for 19.07.2021-15.08.2021

Time	Region	Hour Intervals 8:30 - 9:30	12:30 - 13:30	17:30 - 18:30	Time	Region	Hour Intervals 8:30 - 9:30	12:30 - 13:30	17:30 - 18:30	Time	Region	Hour Intervals 8:30 - 9:30	12:30 - 13:30	17:30 - 18:30
19.07.2021	**A1**	A	A	A	**02.08.2021**	**A1**	A	A	A	**09.08.2021**	**A1**	A	A	A
	A3	A	A	A		**A3**	A	A	A		**A3**	A	A	A
	A4	A	-	A		**A4**	A	A	A		**A4**	A	A	A
	A6	A	A	A		**A6**	A	A	A		**A6**	A	A	A
	A7	A	D	E		**A7**	A	B	C		**A7**	A	C	D
	A8	A	A	A		**A8**	A	A	A		**A8**	A	A	A
	A10	A	A	A		**A10**	A	A	A		**A10**	A	A	A
20.07.2021	**A1**	A	A	A	**03.08.2021**	**A1**	A	A	A	**10.08.2021**	**A1**	A	A	A
	A3	A	A	A		**A3**	A	A	A		**A3**	A	A	A
	A4	A	A	A		**A4**	A	A	A		**A4**	A	A	A
	A6	A	A	A		**A6**	A	A	A		**A6**	A	A	A
	A7	A	A	B		**A7**	A	B	C		**A7**	A	B	C
	A8	A	A	A		**A8**	A	A	A		**A8**	A	A	A
	A10	A	A	A		**A10**	A	A	A		**A10**	A	A	A
21.07.2021	**A1**	A	A	A	**04.08.2021**	**A1**	A	A	A	**11.08.2021**	**A1**	A	A	A
	A3	A	A	A		**A3**	A	A	A		**A3**	A	A	A
	A4	A	A	A		**A4**	A	A	A		**A4**	A	A	A
	A6	A	A	A		**A6**	A	A	-		**A6**	A	A	A
	A7	A	A	B		**A7**	A	B	D		**A7**	A	B	C
	A8	A	A	A		**A8**	A	A	A		**A8**	A	A	A
	A10	A	A	A		**A10**	A	A	-		**A10**	A	A	A
22.07.2021	**A1**	A	A	A	**05.08.2021**	**A1**	A	A	A	**12.08.2021**	**A1**	A	A	A
	A3	A	A	A		**A3**	A	A	A		**A3**	A	A	A
	A4	A	A	A		**A4**	A	A	A		**A4**	A	A	A
	A6	A	A	A		**A6**	A	A	A		**A6**	A	A	A
	A7	A	A	B		**A7**	A	B	C		**A7**	A	B	C
	A8	A	A	A		**A8**	A	A	A		**A8**	A	A	A
	A10	A	A	A		**A10**	A	A	A		**A10**	A	A	A
23.07.2021	**A1**	A	A	A	**06.08.2021**	**A1**	A	A	A	**13.08.2021**	**A1**	A	A	A
	A3	A	A	A		**A3**	A	A	A		**A3**	A	A	A
	A4	A	A	A		**A4**	A	A	A		**A4**	A	A	A
	A6	A	A	A		**A6**	A	A	A		**A6**	A	A	A
	A7	A	A	C		**A7**	A	B	D		**A7**	A	B	C
	A8	A	A	A		**A8**	A	A	A		**A8**	A	A	A
	A10	A	A	A		**A10**	A	A	A		**A10**	A	A	A

24.07.2021	**A1**	A	A	A	**07.08.2021**	**A1**	A	A	A	**14.08.2021**	**A1**	A	A	A
	A3	A	A	A		**A3**	A	A	A		**A3**	A	A	A
	A4	A	A	A		**A4**	A	A	A		**A4**	A	A	A
	A6	A	A	A		**A6**	A	A	A		**A6**	A	A	A
	A7	A	A	C		**A7**	A	C	B		**A7**	A	B	D
	A8	A	A	A		**A8**	A	A	A		**A8**	A	A	A
	A10	A	A	A		**A10**	A	A	A		**A10**	A	A	B
25.07.2021	**A1**	A	A	A	**08.08.2021**	**A1**	A	A	A	**15.08.2021**	**A1**	A	A	A
	A3	A	A	A		**A3**	A	A	A		**A3**	A	A	A
	A4	A	A	A		**A4**	A	A	A		**A4**	A	A	A
	A6	A	A	A		**A6**	A	A	A		**A6**	A	A	A
	A7	A	A	A		**A7**	A	C	B		**A7**	A	B	D
	A8	A	A	A		**A8**	A	A	A		**A8**	A	A	A
	A10	A	A	A		**A10**	A	A	A		**A10**	A	A	A

When a detailed examination was made without including the A7 region among all the results, it was determined that the A2 Kızılay region was at the B level in 7 hour intervals in total, due to the large number of people passing by in the evening. It was observed that 3 of them was in the weekend of the third week. It has been determined that the days on which the other B result is obtained were Mondays and Fridays of the 3rd week. Likewise, on the weekend of the 3rd week, between 17:30 and 18:30 on 14.08.2021, LOS degree was observed as B level in the A10 (Dikimevi) region. Comparison of the results obtained on 14.08.2021 between regions is shown in Table 5.10.

Table 5.10. HCM PLOS Results on 14.08.2021 Saturday

Time	**Region**									
14.08.2021	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
08:30 - 09:30	A	A	A	A	A	A	A	A	A	A
12:30 - 13:30	A	A	A	A	A	A	B	A	A	A
17:30 - 18:30	A	B	A	A	A	A	D	A	A	B

In this process, where the pandemic continued with loosened restrictions, the 3rd week has been determined as the most crowded week as a result of the countings. It has been observed that on Mondays and Fridays LOS results were worse compared to other days of the week. And, it was observed that LOS results of the weekends were worse than weekdays. When the results obtained in all regions were compared with each other, it was observed that the A7 region's results were lower than other regions due to the narrow effective sidewalk width.

5.1.3. Landis Method Results

In order to determine PLOS for Landis, unlike other PLOS methods, hourly vehicle counts were used instead of hourly pedestrian counts. Since peak hour factor is not considered in the Landis Method, the hourly vehicle counts conducted for each region were divided into 4 in order to find average vehicle flow for 15 minute periods. It is observed that motor vehicles were not the only factors that effects the PLOS score for the Landis method. There were 5 main factors affecting the method;

- Lateral separation elements between pedestrians and motor vehicle traffic, including
    - Presence of sidewalk, Width of sidewalk, Buffers between sidewalk and motor vehicle travel lanes, Presence of barriers within the buffer area, Presence of on-street parking, Width of outside travel lane, and Presence and width of shoulder or bike lane;
- Motor vehicle traffic volume;
- Effect of (motor vehicle) speed;
- Motor vehicle mix (i.e., percentage of trucks); and
- Driveway access frequency and volume.

Measurements were made in the field for every necessary factor other than vehicle count, and PLOS values were determined by placing the obtained values into the Equation 3.13. Results of the Landis Method were shared in Table 5.11, Table 5.12, Table 5.13 and Table 5.14.

In each hourly calculated result, for PLOS values, B, C and D values were observed instead of A value this time, unlike the HCM method. In the study, the A3 region was chosen to show an example of PLOS evaluation with the Landis method. Because the Landis method uses American unit systems, the specified measurements have been changed to feet and miles. Fixed values when examined independently of the selected date and time;

Vehicle lane width $Wol = 350\ cm\ \cong 11.48\ ft$, shoulder lane width $Wl = 40\ cm\ \cong 1.31\ ft$, effective sidewalk width $Ws' = 820\ cm\ \cong 26.9\ ft\ \Rightarrow$ sidewalk presence coefficient $fsw = 0$ was determined. In addition to these, since roadside car parking is prohibited throughout the region, but vehicles were waiting on the side of the road, although not necessarily for a long time, the percentage of car park in the segment was taken as $\%OSP = 10$ and the parking coefficient $fp = 0.2$ determined by the method itself. Again, depending on the presence of the vehicle determined by the method, the buffer area barrier coefficient value was taken as $fb = 5.37$. $Wb = 0$ is accepted as there is no buffer on the segment that separates the vehicle road and the pedestrian path. The number of vehicle road lanes is $L = 4$ and the average vehicle speed is taken as $SPD = 55\ kph\ \cong 34\ mph$ calculated in the HCM LOS method.

The only variable used in the Equation 3.13 for the method is the 15-minute periods of hourly vehicle measurements. This value was used not as a peak, but as an average of 1/4 of the vehicle count measured in 1 hour. When the date of 4 August 2021 is examined between 17:30 and 18:30, the number of vehicles in 15 minutes was found to be $Vol15 = 734\ \ veh/15 - min$ and it was used in the Equation 3.13. The PLOS value obtained as a result of the formula was checked in the method's own table and it was found at the PLOS "D" level for this time interval.

Table 5.11. Landis Method 1st Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
19.07.2021	A2	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
20.07.2021	A2	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
21.07.2021	A2	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
22.07.2021	A2	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
23.07.2021	A2	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
24.07.2021	A2	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
25.07.2021	A2	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B

Table 5.12. Landis Method 2nd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
02.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
03.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
04.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
05.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
06.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
07.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
08.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B

Table 5.13. Landis Method 3rd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
09.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
10.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
11.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
12.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
13.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
14.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B
15.08.2021	**A2**	B	B	B	B	B	B	B	B	B	B	B	B
	A5	B	B	B	B	B	B	B	B	B	B	B	B
	A9	B	B	B	B	B	B	B	B	B	B	B	B

Table 5.14. PLOS Results by Landis of peak hours for 19.07.2021-15.08.2021

Time	Region	Hour Intervals			Time	Region	Hour Intervals			Time	Region	Hour Intervals		
		8:30 - 9:30	12:30 - 13:30	17:30 - 18:30			8:30 - 9:30	12:30 - 13:30	17:30 - 18:30			8:30 - 9:30	12:30 - 13:30	17:30 - 18:30
19.07.2021	A1	C	C	C	02.08.2021	A1	C	C	C	09.08.2021	A1	C	C	C
	A3	D	D	D		A3	D	D	D		A3	D	D	D
	A4	B	-	B		A4	B	B	B		A4	B	B	B
	A6	C	C	C		A6	C	C	C		A6	C	C	C
	A7	B	B	B		A7	B	B	B		A7	B	B	B
	A8	C	C	C		A8	D	C	D		A8	D	D	D
	A10	C	C	C		A10	C	C	C		A10	C	C	C
20.07.2021	A1	C	C	C	03.08.2021	A1	B	C	C	10.08.2021	A1	C	C	C
	A3	D	D	D		A3	D	D	D		A3	D	D	D
	A4	B	B	B		A4	B	B	B		A4	B	B	B
	A6	B	B	C		A6	C	C	C		A6	C	C	C
	A7	A	B	B		A7	B	B	B		A7	B	B	B
	A8	C	C	C		A8	D	C	D		A8	D	C	D
	A10	B	C	C		A10	C	C	C		A10	C	C	C
21.07.2021	A1	B	C	C	04.08.2021	A1	C	C	C	11.08.2021	A1	C	C	C
	A3	D	D	D		A3	D	D	D		A3	D	D	D
	A4	B	B	B		A4	B	B	B		A4	B	B	B
	A6	B	B	C		A6	C	C	-		A6	C	C	C
	A7	A	B	B		A7	B	B	B		A7	B	B	B
	A8	C	C	C		A8	D	C	D		A8	D	C	C
	A10	B	C	C		A10	C	C	-		A10	C	C	C
22.07.2021	A1	B	C	C	05.08.2021	A1	C	C	C	12.08.2021	A1	C	C	C
	A3	D	D	D		A3	D	D	D		A3	D	D	D
	A4	B	B	B		A4	B	B	B		A4	B	B	B
	A6	B	B	C		A6	C	C	C		A6	C	C	C
	A7	A	B	B		A7	B	B	B		A7	B	B	B
	A8	C	C	D		A8	D	C	D		A8	D	D	D
	A10	B	C	C		A10	C	C	C		A10	C	C	C
23.07.2021	A1	B	C	C	06.08.2021	A1	C	C	C	13.08.2021	A1	C	C	C
	A3	D	D	D		A3	D	D	D		A3	D	D	D
	A4	B	B	B		A4	B	B	B		A4	B	B	B
	A6	B	B	C		A6	C	C	C		A6	C	C	C
	A7	A	B	B		A7	B	B	B		A7	B	B	B
	A8	C	C	C		A8	D	C	D		A8	D	D	D
	A10	B	C	C		A10	C	C	C		A10	C	C	C

24.07.2021	**A1**	C	C	C	**07.08.2021**	**A1**	C	C	C	**14.08.2021**	**A1**	C	C	C
	A3	D	D	D		**A3**	D	D	D		**A3**	D	D	D
	A4	B	B	B		**A4**	B	B	B		**A4**	B	B	B
	A6	B	B	C		**A6**	C	C	C		**A6**	B	C	C
	A7	A	B	B		**A7**	B	B	B		**A7**	B	B	B
	A8	C	C	C		**A8**	D	D	D		**A8**	D	C	D
	A10	C	C	C		**A10**	C	C	C		**A10**	C	C	C
25.07.2021	**A1**	C	C	C	**08.08.2021**	**A1**	C	C	C	**15.08.2021**	**A1**	C	C	C
	A3	D	D	D		**A3**	D	D	D		**A3**	D	D	D
	A4	B	B	B		**A4**	B	B	B		**A4**	B	B	B
	A6	B	B	B		**A6**	C	C	C		**A6**	C	C	C
	A7	A	B	B		**A7**	B	B	B		**A7**	B	B	B
	A8	C	C	C		**A8**	D	D	D		**A8**	D	D	D
	A10	C	C	C		**A10**	C	C	C		**A10**	C	C	C

For Landis method, for three regions (A2, A5, A9), PLOS degrees were found B for all of the time intervals, but for others different results such as C and D can be seen. The reason of this can be that this method does not interested in number of pedestrians, but number of vehicles near of the sidewalks were significant. And widths of shoulder lane, buffer, side walk, width outside lane and present of segment with on street parking were important and these elements have different properties with each other for different areas. Therefore, various results can be seen for this method for different regions. In the examination process of the method results, PLOS differences among regions were observed but difference among time intervals. But, it was also observed that there was not much difference between time intervals. Although vehicle counts of the roadway were used in the method, this study showed that the other factors affecting the PLOS were more effective to determine the PLOS grade.

In the examination of Landis method results, it was observed that all regions were at peak levels on 15.08.2021. For this time being all of the region's result were shared in Table 5.15. In regions A1, A2, A3, A4, A5 and A9, there were no changes observed in PLOS levels depending on time. In the results of the first week, higher PLOS values were observed in the A6, A7, A8 and A10 regions compared to the other weeks. While B and C values were observed in the first week in the A6 region, mostly C result was observed in the following weeks. Likewise, while C and D results were observed in the A8 region in the first week, mostly D results were observed in the following weeks. In the A7 region, level A was observed every morning of the first week, but the PLOS value was not determined as A in any of the hours after first week. In the A10 region, only on weekdays of the first week B level was observed, and PLOS value was observed as C level in all other time intervals. When this information is evaluated, it can be thought that weekends worse results were observed than weekdays. However, higher results were observed in the A6 and A8 regions on Saturday of the third week compared to Friday. Since this situation does not happen every week, it can be thought that Sundays generally worse results were observed than the rest of the week. When all the results of the method were evaluated, with D level PLOS value in every time interval, A3 (Kızılay) was determined as the worst region among others. Contrary to the HCM method, according to this method A7 (Demet) region was observed as the better region among others, since region has A level PLOS values in the first week.

Table 5.15. Landis PLOS Results on 15.08.2021 Sunday

Time	**Region**									
15.08.2021	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
08:30 - 09:30	C	B	D	B	B	C	B	D	B	C
12:30 - 13:30	C	B	D	B	B	C	B	D	B	C
17:30 - 18:30	C	B	D	B	B	C	B	D	B	C

5.1.4. Mozer's Method Results

In Mozer's method, PLOS values were associated with stress levels, and PLOS values were determined by using 4 main stress level factors and 3 auxiliary stress level factors in this way. Unlike other methods, the worst value is specified as E, not F. For this reason, these values were shown as E – F in the result table in order to ensure continuity in the study. Mozer's method is also one of the rare PLOS studies that takes into account disabled people for a stress value determined within their main factors. Apart from this, although the formulas were different, the parameters used in general have remained constant and have been used in this method.

Since the study of this method was carried out as a multimodal study, the number of vehicles using the segment also became a factor for Mozer's PLOS value. In addition, while determining the parameters for the factors, Mozer carried out its work by adding

Mode split that is none pedestrians, waiting times at the lights at the intersections and Aesthetic Quality to the main factors in its work, unlike the current methods. At the same time, pedestrian waiting time was found by looking at the red light time for pedestrians in places with pedestrian crossings.

For the factors that depend on human decision, information was obtained by consulting the Municipality experts and individuals using the segment for transportation, just like in the Landis method. Results of the Mozer's PLOS method were shared in Table 5.16, Table 5.17, Table 5.18 and Table 5.19.

In the study, the A5 region was chosen to show an example of PLOS evaluation with the Mozer method. Fixed values when examined independently of the selected date and time; The vehicle speed was taken as $SPEED = 51\ km/h$, which was found from HCM LOS, and the number of lanes was taken as $LN = 2$. Effective sidewalk width was measured as $WWA = 2.2\ m$ and $NPM = 0$ was taken since there is no mode split on the sidewalk. Aesthetic quality was determined as $EQ = 1$, Travel pattern factor was determined as $TP = 2$ since there was movement in both directions on the sidewalk, and $FD = 5$ as facility design factor was not suitable for disabled individuals. Since there was no buffer, $WBW = 0$ was taken and access points per kilometer were determined as $N = 5$. Pedestrians' waiting times at red lights were observed as $PedWait = 31\ sec$.

When examined between 12:30 and 13:30 on August 2, 2021, the number of vehicles passing per hour and the number of pedestrians were measured as $vehPHV = 291$ & $pedPHV = 419$, respectively. With the obtained values, using the Equations 3.14, 3.15, 3.16, 3.17, 3.18 stress levels were determined and as a result, PLOS at the "E" degree was determined. Since there is no value specified for the "F" level in the method, the results with "E" were evaluated as the worst condition fort his method.

Table 5.16. Mozer's Method 1st Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
19.07.2021	A2	D	D	E	E	E	E	E	D	E	E	D	D
	A5	D	D	D	D	E	E	E	E	E	E	E	E
	A9	D	E	E	E	E	E	E	E	E	E	E	E
20.07.2021	A2	D	D	D	D	D	D	D	D	D	E	E	D
	A5	C	D	D	D	D	D	D	D	D	D	D	D
	A9	D	D	D	D	E	E	E	E	E	E	E	E
21.07.2021	A2	D	D	D	D	D	D	D	D	D	D	D	D
	A5	C	C	C	C	D	D	D	D	D	D	E	E
	A9	D	D	D	D	E	E	E	E	E	E	E	E
22.07.2021	A2	D	D	D	D	D	D	D	D	D	E	E	E
	A5	C	D	D	C	D	D	D	D	D	D	D	D
	A9	C	D	D	D	E	E	E	E	E	E	E	E
23.07.2021	A2	D	D	D	D	D	E	D	D	D	E	E	E
	A5	C	D	D	D	D	D	D	D	D	D	D	D
	A9	C	D	D	D	E	E	E	E	E	E	E	E
24.07.2021	A2	D	D	D	D	D	E	E	E	E	E	E	E
	A5	C	C	C	D	D	D	D	D	D	D	E	D
	A9	C	D	D	D	D	E	E	E	E	E	E	E
25.07.2021	A2	D	D	E	E	E	E	E	E	E	E	E	E
	A5	C	D	D	D	D	D	D	D	D	D	D	D
	A9	C	D	D	D	D	E	E	E	E	E	E	E

Table 5.17 Mozer's Method 2nd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
02.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	D	D	D	D	E	D	D	D	E	E	E
	A9	D	E	E	D	E	E	E	E	E	E	E	E
03.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	E	D	D	D	E	D	D	D	D	E	E
	A9	D	E	D	E	E	E	E	E	E	E	E	E
04.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	D	D	D	D	E	D	D	D	D	E	D
	A9	D	E	D	E	E	E	E	E	E	E	E	E
05.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	E	D	D	D	E	D	D	D	D	E	E
	A9	D	D	D	E	E	E	E	E	E	E	E	E
06.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	E	D	D	D	E	D	D	D	E	E	E
	A9	D	E	E	E	E	E	E	E	E	E	E	E
07.08.2021	A2	E	E	D	E	E	E	E	E	E	E	E	E
	A5	C	D	D	D	E	E	E	E	E	E	E	E
	A9	D	D	D	E	E	E	E	E	E	E	E	E
08.08.2021	A2	E	E	D	E	E	E	E	E	E	E	E	E
	A5	C	D	D	D	E	E	E	E	E	E	E	E
	A9	D	D	D	E	E	E	E	E	E	E	E	E

Table 5.18. Mozer's Method 3rd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
09.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	E	E	E	E	E	E	E	E	E	E	E
	A9	D	E	E	E	E	E	E	E	E	E	E	E
10.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	E	D	D	D	E	E	D	E	E	E	E
	A9	D	E	E	E	E	E	E	E	E	E	E	E
11.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	E	E	E	D	E	E	D	E	E	E	E
	A9	E	E	E	E	E	E	E	E	E	E	E	E
12.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	E	D	D	E	E	E	D	E	E	E	E
	A9	D	E	E	E	E	E	E	E	E	E	E	E
13.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	D	D	D	E	E	E	E	E	E	E	E
	A9	E	E	E	E	E	E	E	E	E	E	E	E
14.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	D	D	D	D	E	E	E	E	E	E	E
	A9	E	E	E	E	E	E	E	E	E	E	E	E
15.08.2021	A2	E	E	E	E	E	E	E	E	E	E	E	E
	A5	D	D	D	D	D	E	E	E	E	E	E	E
	A9	D	E	D	E	E	E	E	E	E	E	E	E

Table 5.19. PLOS Results by Mozer of peak hours for 19.07.2021-15.08.2021

Time	Region	8:30 - 9:30	12:30 - 13:30	17:30 - 18:30	Time	Region	8:30 - 9:30	12:30 - 13:30	17:30 - 18:30	Time	Region	8:30 - 9:30	12:30 - 13:30	17:30 - 18:30
19.07.2021	**A1**	E	E	E	**02.08.2021**	**A1**	E	E	E	**09.08.2021**	**A1**	E	E	E
	A3	E	E	E		**A3**	E	E	E		**A3**	E	E	E
	A4	E	-	E		**A4**	E	E	E		**A4**	E	E	E
	A6	E	E	E		**A6**	E	E	E		**A6**	E	E	E
	A7	E	E	E		**A7**	E	E	E		**A7**	E	E	E
	A8	C	C	C		**A8**	D	C	C		**A8**	D	C	C
	A10	E	E	E		**A10**	E	E	E		**A10**	E	E	E
20.07.2021	**A1**	D	E	E	**03.08.2021**	**A1**	C	D	E	**10.08.2021**	**A1**	E	E	E
	A3	D	E	E		**A3**	E	E	E		**A3**	E	E	E
	A4	D	E	E		**A4**	E	E	E		**A4**	E	E	E
	A6	D	D	E		**A6**	E	E	E		**A6**	E	E	E
	A7	D	E	E		**A7**	E	E	E		**A7**	E	E	E
	A8	C	C	C		**A8**	D	C	C		**A8**	D	C	C
	A10	E	E	E		**A10**	E	E	E		**A10**	E	E	E
21.07.2021	**A1**	C	D	E	**04.08.2021**	**A1**	E	E	E	**11.08.2021**	**A1**	E	E	E
	A3	D	E	E		**A3**	E	E	E		**A3**	E	E	E
	A4	D	E	E		**A4**	E	E	E		**A4**	E	E	E
	A6	D	D	E		**A6**	E	E	-		**A6**	E	E	E
	A7	D	E	E		**A7**	E	E	E		**A7**	E	E	E
	A8	C	C	C		**A8**	D	C	C		**A8**	C	C	C
	A10	D	E	E		**A10**	E	E	-		**A10**	E	E	E
22.07.2021	**A1**	D	D	E	**05.08.2021**	**A1**	D	D	E	**12.08.2021**	**A1**	E	E	E
	A3	D	E	E		**A3**	E	E	E		**A3**	E	E	E
	A4	D	E	E		**A4**	E	E	E		**A4**	E	E	E
	A6	D	D	E		**A6**	E	E	E		**A6**	E	E	E
	A7	D	E	E		**A7**	E	E	E		**A7**	E	E	E
	A8	C	C	C		**A8**	D	C	C		**A8**	D	C	C
	A10	E	E	E		**A10**	E	E	E		**A10**	E	E	E
23.07.2021	**A1**	C	E	E	**06.08.2021**	**A1**	E	E	E	**13.08.2021**	**A1**	E	E	E
	A3	D	E	E		**A3**	E	E	E		**A3**	E	E	E
	A4	D	E	E		**A4**	E	E	E		**A4**	E	E	E
	A6	D	E	E		**A6**	E	E	E		**A6**	E	E	E
	A7	D	E	E		**A7**	E	E	E		**A7**	E	E	E
	A8	C	C	C		**A8**	D	C	C		**A8**	D	C	C
	A10	E	E	E		**A10**	E	E	E		**A10**	E	E	E

24.07.2021	**A1**	D	E	E	**07.08.2021**	**A1**	E	E	E	**14.08.2021**	**A1**	E	E	E
	A3	D	E	E		**A3**	E	E	E		**A3**	E	E	E
	A4	D	E	E		**A4**	E	E	E		**A4**	E	E	E
	A6	D	D	E		**A6**	E	E	E		**A6**	E	E	E
	A7	D	E	E		**A7**	E	E	E		**A7**	E	E	E
	A8	C	C	C		**A8**	D	C	C		**A8**	C	C	C
	A10	E	E	E		**A10**	E	E	E		**A10**	E	E	E
25.07.2021	**A1**	D	E	E	**08.08.2021**	**A1**	E	E	E	**15.08.2021**	**A1**	E	E	E
	A3	D	E	E		**A3**	E	E	E		**A3**	E	E	E
	A4	D	E	E		**A4**	E	E	E		**A4**	E	E	E
	A6	D	D	E		**A6**	E	E	E		**A6**	E	E	E
	A7	D	E	D		**A7**	E	E	E		**A7**	E	E	E
	A8	C	C	C		**A8**	D	C	C		**A8**	C	C	C
	A10	E	E	E		**A10**	E	E	E		**A10**	E	E	E

For Mozer's Method, since the first week is holiday week in Turkey, C and D levels were also observed among the results fort he first week. Other than A8 (Kurtuluş) region, all of the peak results of the other regions were observed as "E" level which is the worst score for the Mozer's method. For the A8 region, due to presence of a very wide sidewalk and low number of pedestrians the peak result was found as level "D". As a result of the study conducted, among the factors affecting this lower PLOS degree, number of vehicle lanes and number of driveways were also found very effective. For A8 region it was also observed that morning hours were mostly found to be in a worse condition than other peak hours. The reason for this was determined to be the high number of vehicles using that roadway in the morning hours compared to other hours.

When the A2, A5, A9 regions were examined, the worst results were observed in the 3rd week. It was observed that some weekday results were worse than the weekend results for A5 and A9. In the first week, C level results were observed for A5 and A9 in the morning, but for the other weeks, C level was not observed. While D levels were observed for some hourly intervals in A2 region from the beginning of the week of the 1st week, this level gradually decreased towards the end of the week and from the end of the 1st week. Only E level was observed in the other weeks for A2 region.

In the regions where only the peak hour counts were made, E level was observed in all regions except the A8 region. It was observed that the results of the 2nd week were worse than the 1st week, and the results of the 3rd week were worse than the 2nd week. It was observed that the results were better in the A8 region compared to other regions. D level was found as the worse among others PLOS value for A8 region and it was determined that this level was observed only between 8:30 and 9:30 hour intervals in the morning. When the results of the 2nd week were examined, all regions were observed at the E level, except for the A1 and A8 regions. On Tuesday and Thursday of the 2nd week, especially due to the decrease in the number of pedestrians, C and D levels were observed in the A1 region until the evening hours.

When all regions were evaluated, no definite conclusion could be reached for the better-worse relationship between weekdays and weekends. While some regions had better results on weekdays and worse results on weekends, for some of the regions the opposite of this situation was observed and for some regions no difference was observed. Since the number of pedestrians using the route of A8 region is less than other regions and the number of vehicle road lanes is higher than other regions, better results than other regions were observed. A3 (Kızılay) and A4 (Dutluk) regions were determined as the worse regions among others according to the Mozer's method, since their results were observed as D level only between 8:30 and 9:30 in the morning in the first week, and E in other time intervals.

When all 10 regions were evaluated, it was determined that the peak results were observed on Monday of the 3rd week and were shared in Table 5.20. In order to compare the results determined during the week with the weekend, the results observed on Saturdays of the 2nd week and the 3rd week were also shared separately in Table 5.21. In order to compare all regions on Table 5.21, the peak hours were shown, but there were hour intervals where higher levels were observed in the A5 and A9 regions, except for the peak hours.

Table 5.20 Mozer Method PLOS Results on 09.08.2021 Monday

Time	**Region**									
09.08.2021	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
08:30 - 09:30	E	E	E	E	E	E	E	D	E	E
12:30 - 13:30	E	E	E	E	E	E	E	C	E	E
17:30 - 18:30	E	E	E	E	E	E	E	C	E	E

Table 5.21 Mozer Method PLOS Results on Saturdays of 2nd and 3rd week

Time		Region									
		A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
07.08.2021	**08:30 - 09:30**	E	E	E	E	D	E	E	D	D	E
	12:30 - 13:30	E	E	E	E	E	E	E	C	E	E
	17:30 - 18:30	E	E	E	E	E	E	E	C	E	E
14.08.2021	**08:30 - 09:30**	E	E	E	E	D	E	E	C	E	E
	12:30 - 13:30	E	E	E	E	E	E	E	C	E	E
	17:30 - 18:30	E	E	E	E	E	E	E	C	E	E

5.1.5. Tan Dandan Method Results

For the application of the method, the bicycle, motorcycle, pedestrian and vehicle counts require 5-minute periods. However, since 3-minute periods were counted from the videos, the 15-minute values were calculated and they were divided into 3 to find 5 minute periods. Except for these values, the method was used in the Equation 3.19 for the width between the sidewalk and the roadway, which was measured in the field survey.

When the hourly results from the regions were examined, it was noticed that the method's main dependency is on the lateral clearance which used in Equation 3.19. For this reason, although 5-minute periods were considered for both motor vehicles and pedestrians, it has been understood that the factor that changes the formula result the most is the distance between the sidewalk and the vehicle road. Results of the Tan Dandan method were shared in Table 5.22, Table 5.23, Table 5.24 and Table 5.25. While making the comparison, peak results were used for these regions, just as peak results were used in the calculations made in accordance with the HCM method.

In the study, the A6 region was chosen to show an example of PLOS evaluation with the Tan Dandan method. Fixed values when examined independently of the selected date and time; For the driveway access quantity per meter $P_{1000} = 6$ per kilometer was determined and the value of $P = 0.006$ per meter was accepted for the formula. The lateral clearance was measured in situ as $Wr = 0.8$.

For each region, the highest 15-minute periods were determined and divided into 3 to find the 5 minute periods. When the date of 13 August 2021 is examined between 8:30 and 9:30, the results for vehicle, pedestrian and bicycle-motorcycle etc. for 5-minute periods were observed as $Q_v = 124, Q_p = 48, Q_b = 0$ respectively. When the found values were placed in the Equation 3.19 the PLOS value for the specified date and time is found as "F" level.

Examination of the results for Tan Dandan method has shown that PLOS degree for A2, A5, A9 regions were all “A” level. Change in results were not observed in these regions. However, for the other regions, through A to F different results can be seen from the Table 5.20. It was understood that the most effective factor for Tan Dandan method is the distance between sidewalk and the vehicular traffic lane. This value is observed as 1.9 meters for A2 region and for other 2 regions there was also parking occur and creates a space more than 1.5 meters to the traffic lane. When different values such as 0.5 meter distance was tried in the Equation 3.19, it was observed that most of the results for this three regions turned to be F level. However, increasing the number of pedestrians does not have this much of an effect on the PLOS level found. Other than these three regions some differences on PLOS levels also can be seen for different hour intervals. The reason of this can be explained with the change in the vehicle numbers. Despite the fact that Tan Dandan method is interested in vehicle, pedestrian and bicycle counts most effective factor among all of them was found as distance between sidewalk and the traffic lane and second effective factor was found as vehicle counts.

Table 5.22. Tan Dandan Method 1st Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
19.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
20.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
21.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
22.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
23.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
24.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
25.07.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A

Table 5.23 Tan Dandan Method 2nd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
02.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
03.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
04.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
05.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
06.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
07.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
08.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A

Table 5.24. Tan Dandan Method 3rd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
09.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
10.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
11.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
12.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
13.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
14.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A
15.08.2021	A2	A	A	A	A	A	A	A	A	A	A	A	A
	A5	A	A	A	A	A	A	A	A	A	A	A	A
	A9	A	A	A	A	A	A	A	A	A	A	A	A

Table 5.25. PLOS Results by Tan Dandan of peak hours for 19.07.2021-15.08.2021

Time	Region	Hour Intervals			Time	Region	Hour Intervals			Ti	Region	Hour Intervals		
		8:30 - 9:30	**12:30 - 13:30**	**17:30 - 18:30**			**8:30 - 9:30**	**12:30 - 13:30**	**17:30 - 18:30**			**8:30 - 9:30**	**12:30 - 13:30**	**17:30 - 18:30**
19.07.2021	**A1**	A	C	A	**02.08.2021**	**A1**	D	E	E	**09.08.2021**	**A1**	C	F	A
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	-	F		**A4**	F	F	F		**A4**	F	F	F
	A6	D	E	E		**A6**	F	F	F		**A6**	F	F	F
	A7	A	D	A		**A7**	B	A	A		**A7**	B	A	A
	A8	F	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F
20.07.2021	**A1**	A	A	A	**03.08.2021**	**A1**	A	A	A	**10.08.2021**	**A1**	D	D	C
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	A	A	D		**A6**	F	F	F		**A6**	F	F	F
	A7	A	A	B		**A7**	B	A	B		**A7**	C	B	B
	A8	F	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F
21.07.2021	**A1**	A	A	A	**04.08.2021**	**A1**	C	E	C	**11.08.2021**	**A1**	D	C	A
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	A	A	D		**A6**	F	F	-		**A6**	F	E	F
	A7	A	A	B		**A7**	A	A	A		**A7**	B	A	B
	A8	F	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	-		**A10**	F	F	F
22.07.2021	**A1**	A	A	A	**05.08.2021**	**A1**	A	A	A	**12.08.2021**	**A1**	B	C	A
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	A	B	D		**A6**	F	E	F		**A6**	F	F	F
	A7	A	A	B		**A7**	A	A	B		**A7**	D	A	C
	A8	F	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F
23.07.2021	**A1**	A	A	B	**06.08.2021**	**A1**	A	C	A	**13.08.2021**	**A1**	B	C	C
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	A	B	D		**A6**	F	F	F		**A6**	F	C	F
	A7	A	A	A		**A7**	C	A	A		**A7**	A	A	A
	A8	F	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F

24.07.2021	**A1**	A	A	B	**07.08.2021**	**A1**	D	D	B	**14.08.2021**	**A1**	A	C	D
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	B	B	D		**A6**	F	E	F		**A6**	C	E	D
	A7	A	A	A		**A7**	A	B	A		**A7**	A	A	A
	A8	F	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F
25.07.2021	**A1**	A	A	A	**08.08.2021**	**A1**	C	D	C	**15.08.2021**	**A1**	C	B	D
	A3	F	F	F		**A3**	F	F	F		**A3**	F	F	F
	A4	F	F	F		**A4**	F	F	F		**A4**	F	F	F
	A6	A	B	C		**A6**	F	F	F		**A6**	E	F	F
	A7	A	A	A		**A7**	A	B	A		**A7**	A	B	B
	A8	F	F	F		**A8**	F	F	F		**A8**	F	F	F
	A10	F	F	F		**A10**	F	F	F		**A10**	F	F	F

Generally, except for the exceptions, higher level PLOS values were observed in the 1st week compared to the other weeks. While examining the method, it has been observed that the number of bicycles is a greater factor than the vehicle and pedestrian, according to Equation 3.19. Due to the differences in the number of bicycles and motorcycles, lower levels were observed in the 2nd week compared to the 3rd week. PLOS level F was observed in the A1 region between 12:30 and 13:30 on 09.08.2021, and no F level was observed in the A1 region at any other time. In order to show other regions in this time period, the results of the peak hours of 09.08.2021 were shared in Table 5.26.

Table 5.26 Tan Dandan Method PLOS Results on 09.08.2021

Time	**Region**									
09.08.2021	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
08:30 - 09:30	C	A	F	F	A	F	B	F	A	F
12:30 - 13:30	F	A	F	F	A	F	A	F	A	F
17:30 - 18:30	A	A	F	F	A	F	A	F	A	F

Since the number of bicycles were a major factor and no counting on bicycles were observed in a regular pattern, a definite better-worse relationship between days and weeks could not be concluded. The results of the Mondays of the 2nd and 3rd weeks were shared in Table 5.27 to summarize this situation. According to the Tan Dandan method, A2, A5 and A9 regions were determined to be the better regions among others, while the A3, A4, A8 and A10 regions were determined as the worse regions among others as no better

PLOS result than F was observed in these regions. The main reason for A3, A4, A8 and A10 to be the worse regions among others can be explained with that the distance between the road lane and the sidewalk is short or not precense at all in these regions.

Table 5.27 Tan Dandan Method PLOS Results on Mondays and Saturdays of 2nd and 3rd week

Time			Region									
			A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
Monday	**02.08.2021**	**08:30 - 09:30**	D	A	F	F	A	F	B	F	A	F
		12:30 - 13:30	E	A	F	F	A	F	A	F	A	F
		17:30 - 18:30	E	A	F	F	A	F	A	F	A	F
	09.08.2021	**08:30 - 09:30**	C	A	F	F	A	F	B	F	A	F
		12:30 - 13:30	F	A	F	F	A	F	A	F	A	F
		17:30 - 18:30	A	A	F	F	A	F	A	F	A	F
Saturday	**07.08.2021**	**08:30 - 09:30**	D	A	F	F	A	F	A	F	A	F
		12:30 - 13:30	D	A	F	F	A	E	B	F	A	F
		17:30 - 18:30	B	A	F	F	A	F	A	F	A	F
	14.08.2021	**08:30 - 09:30**	A	A	F	F	A	C	A	F	A	F
		12:30 - 13:30	C	A	F	F	A	E	A	F	A	F
		17:30 - 18:30	D	A	F	F	A	D	A	F	A	F

5.1.6. Results of Non-Hourly Methods

In this section, 6 different methods, which were independent of time, were studied. Therefore, hourly counts were not significant effect for them. In the Table 5.28, the results of all 10 regions for 6 methods were given. The 6 methods examined were Disabled PLOS for Persons with Disabilities, Sarkar's, Trip Quality Method, Gainesville, Conjoint Method, Australian Method, respectively.

5.1.6.1. Disabled PLOS Method Results

This study by Zohreh Asadi-Shekari and his team were the only study in the literature in which the pedestrian service level is calculated by considering only disabled people. All of the necessary information in the study was carried out with the measurements made during the field examination

In order for the method to give proper and correct results, each of the 10 selected regions was visited and the existing ramps, slopes and border crossings were measured in meters. Considering the length of the segment, the road slope was examined and the sidewalk areas of the segments discussed in the study were calculated. Apart from these, whether there is an elevator or not, and if there is, its dimensions were taken into account. In the same way, whether there is a toilet or not and although it is known that there is not much used in Turkey in the surrounding region, the presence of drinking water fountains was checked. Since it is a special method for disabled individuals, an evaluation has been made by examining at the presence of tactile sidewalk, its width and its presence in crossings. For crossings, it has also been evaluated within the method by taking into account whether there is a signal for traffic lights.

When the service level of each region is evaluated according to the disabled individuals, the results in the study were between C and E values. Results of the DPLOS method were shared in Table 5.28. Each of the indicators that were taken into account for Disabled PLOS method has a different multiplier determined by Zohreh Asadi-Shekari et al. (2013). It was observed that slope of sidewalk and ramps, presence of curb ramps, signal at traffic lights and tactile sidewalks were the significant factors of the DPLOS method. This is the reason that while A1 region has a score of LOS C and A9 region has a score of LOS E. In the conducted studies, even though it is not continuous for all af the segment, presence of the tactile sidewalk, signal at traffic lights and presence of almost enough curb ramps was observed for A1 region while A9 region was lacking most of these indicators.

In the study, the A9 region was chosen to show an example of PLOS evaluation with the Disabled PLOS method. Since the result of this method does not change value according to date and time, the region has only one result.

Since the walking area slope for the selected region is higher than 2%, $DI1 = 0$ was taken. Since there is no elevator on the segment, $DI2 = 0$ was taken. The number of curb ramps required in the region has been determined as 5, but since the region has 1, it was taken as $DI3 = 0.2$. Since there is no water drinking fountain in the region, $DI3 = 0$ was taken. Since there is no tactile sidewalk for disabled individuals, $DI5 = 0$ & $DI6 = 0$ values were taken. The required number of ramps on the sidewalk has been determined as 1, and since the segment does not have any ramps, it was taken as $DI7 = 0$. Since there is no toilet on the segment, it was taken as $DI8 = 0$. Since the grade of the entire region remained below 5%, $DI9 = 1$ was taken. The number of signals required in the region was determined as at least 2, but since there were no signals, it was taken as $DI10 = 0$. When all indicator values were multiplied and added by their own multipliers, the service level of the region was found to be "E".

5.1.6.2. Sarkar's Method Results

The PLOS level determined in Sarkar's method is found by the average of the marked values based on the observations. The 5 main factors under examination were taken into account. Which were; physical and psychological components, resting places quality, weather factors, sound levels and air pollution.

Each determined factor was noted by observations by going directly to its points in field measurements and processed in excel tables. As a result of the method, which was carried out by considering only environmental factors, based on observations without recording the number of people and vehicles, the results were between B - F values for all hours' calculations. Results of the Sarkar's method were shared in Table 5.28. It was observed that Sarkar's method is only interested in environmental factors rather than infrastructure and counting data. Even though A7 (Demet) region has a very narrow effective walkway but was observed as PLOS C according to Sarkar's method can be explained that way. Good quality resting areas and lots of green areas were observed for region A7. A8 (Kurtuluş) region has also good resting areas away from the effective walkway and also with the help of a wide effective walkway, physical effort is minimized at great levels for this region. While the PLOS value was calculated as B for the A8 region, the PLOS value was determined as F for the A2 (Kızılay) region due to the lack of rest areas, the difficulty of protecting and the physical effort required to walk on the sidewalk.

With Sarkar's method, a table was prepared for PLOS evaluation and the values of the indicators were determined and marked during the measurements made on site. First of all, the subtitles of the 5 main indicators were evaluated and graded as $F = 1, D = 2, C = 3, B = 4, A = 5$. For each main indicator, the average of the indicators was calculated and the value was written. Then, in order to find a single value, the average of 5 main indicators was taken and the PLOS grade was evaluated. Since the result of this method does not change value according to date and time, the region has only one result.

5.1.6.3. Trip Quality Method Results

Since Jaskiewicz's Trip Quality method is a method performed with two observers, results were obtained by having two people evaluate on separate papers during field measurements. Separate observers for each location recorded their own scoring. It was thought that it would be a good method study for the Ankara region, since the method is particularly adaptable to inner-city areas and deals with environmental factors.

When the results were compared, the grades were obtained according to the scores obtained from the observers; the same grade was determined by the observers with a rate of 70% for 10 regions. In the results of the other three regions that were not the same, no high score difference other than one degree was observed between them. In such cases, the values were defined against the scores and their averages were taken as a result.

Results of the Trip Quality method were shared in Table 5.28. For Trip Quality method, it was observerd that for all the regions PLOS results vary from B to D. It was observed that Trip Quality method even considers the vehicle traffic speed by observation without being based on a calculation. Even though, Trip Quality method does not interest in the calculations or the countings, evaluation was made entirely from the perspective of pedestrians. Since method was conducted with two different observers, difference PLOS levels between regions can be seen.

Similar to Sarkar's method, a table was prepared for PLOS evaluation with the Trip Quality method, and the values of the indicators were determined and marked by 2 different observers during the measurements made on site. By taking the average of the scores, the PLOS result was found for 2 different observers, and a single PLOS value was calculated by looking at the average of the results found. Since the result of this method does not change value according to date and time, the region has only one result.

5.1.6.4. Gainesville Method Results

As mentioned before, the Gainesville method was carried out by considering the existing conditions of sidewalks and other infrastructures. In each of the 10 regions selected for the application of the method, on-site observations were made and the necessary areas were marked. Apart from the infrastructure, the method also included Motor Vehicle LOS and used it in the scoring system.

It was observed that Gainesville Method takes into account the vehicle LOS value among the categories considere. However, since the LOS value was not higher than E in any of the regions in general, this score was taken as 0 for each region and the method continued to be applied. Results of the Gainesville method were shared in Table 5.28. As well as some environmental effects were considered, most effective factors were found as infrastructure data for Gainesville Method. Since most of the selected areas in Ankara have problems with the sidewalk and none of them have multi-model support, D and E levels were observed as a result of this PLOS method.

Just like in Mozer's method, in this method, attention was paid to the waiting times of pedestrians at the red light, but this time the criterion of this waiting time was taken as 40 seconds and used in the method. In the expected regions less than 40 seconds, this factor increased the total score by 0.5 and showed its effect within the method.

According to this method, improvements should be considered for Ankara's pedestrian walkways, since no region has a PLOS value higher than. However, it was determined that evaluating a whole region by applying this method alone is not an adequate criterion, since the method considers 6 main factors piece by piece. For Gainesville, measurements made in the field were used in Table 3.31. A9 (Pursaklar) region was choosen to be examined. Pedestrian facility was observed as continuos on boths sides, and 6 points were taken from this criterion. Sidewalk width was observed more than 1.5 meters so 1 point was taken for this criteria. Frequent problems were observed on the sidewalk of the region therefore -1 point was taken from this criterion. Some shade trees were observed in this region and also less than 18 meters of crossing width was measured during the site visit. Therefore, respectively, 0.5 points and 0.5 points were taken for these criterias from Table 3. 31. Since the posted speed of Ankara city roads were known as 50 km/h, this criterion also was taken as 0.5 points for all the regions. The summation of the points were found as 7.50 for the A9 region. When this value was compared in Table 3.32, the correspondin PLOS D value was found for region A9. Since the result of this method does not change value according to date and time, the region has only one result.

5.1.6.5. Conjoint Analysis Method Result

Although the Conjoint Analysis method, which was developed in China, mostly makes an assessment with the density of people in intersection areas, it is a method that can also be used in pedestrian road segments. Conjoint Analysis, which is a very simple method, only observes the pedestrian segment in 3 levels and 4 categories.

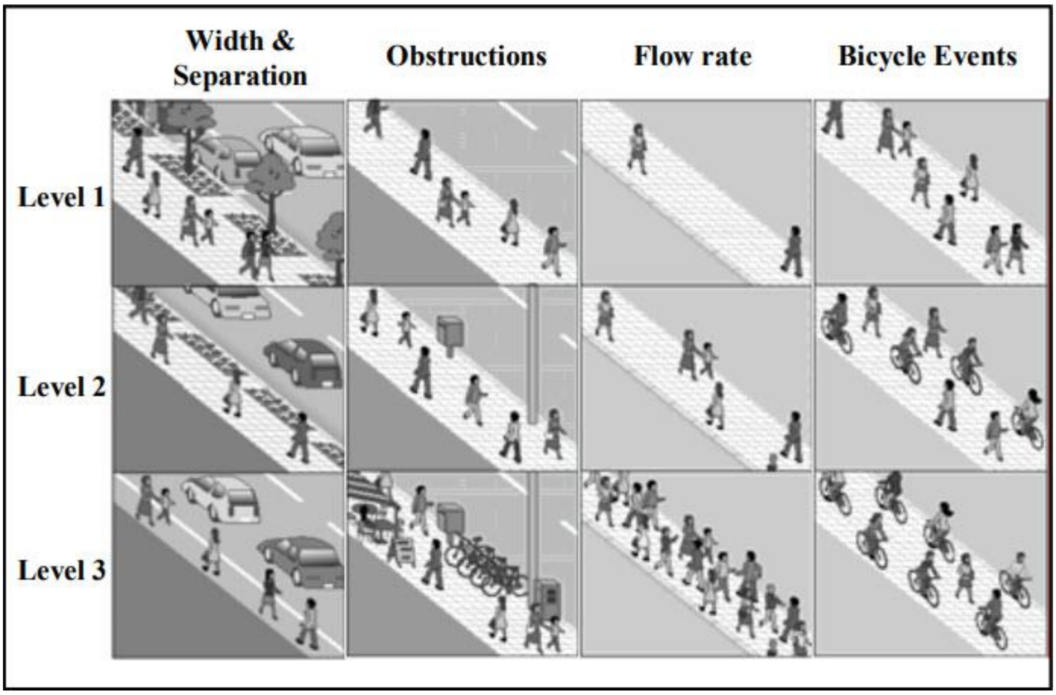

Figure 5.1. Attributes and Levels of Sidewalk for Conjoint Analysis (Muraleetharan, 2006)

Level 1 is the best level and Level 3 is the worst level as it can be understood from the Figure 5.1. In this method, as an example of levels, the figure above is shared with the work done by Muraleetharan and his team.

In addition to the pedestrian and bicycle counts made in the municipality, the width and obstacles, which were also observed and measured at the field site, were also used in the method. While scoring in the method, a scale was set from the highest to the lowest using the values given by Muraleetharan, and the scoring was divided evenly so that the LOS levels can be taken as 6 different levels from A to F.

When the calculations were completed for each region, it was observed that the results obtained were B for the 9 regions. Only the result of the region A8 (Kurtuluş) was found as Level A. This may mean that working with fewer factors affecting PLOS can lead people working on pedestrian level of services to wrong conclusions. When the results were examined in general, it was observed that they were quite different and higher than the other results. Results of the Conjoint Analysis method were shared in Table 5.28. To conduct the Conjoint Analysis method, bicycle events per hour that were shown as <60 for Level 1 in Table 3.34 were taken as Level 1 for all regions. And pedestrian flow rates as in ped/min/m were also taken Level 1 for almost all of the regions. The reason of there is not much difference between regions may be explained by the fact that method uses few indicators and has few factors affecting the PLOS value.

In the study, the A10 region was chosen to show an example of PLOS evaluation with the Conjoint Analysis method. Since the result of this method does not change value according to date and time, the region has only one result. The sidewalk width for the region was determined as $1.5 \leq Width < 3$ and Level 2 value was taken. The number of obstacles in 100 meters was determined as between 1 and 5, therefore Level 2 value was taken. For pedestrian flow rate and bicycle mobility, the minimum and maximum values for all dates and times were considered and it was determined that both were Level 1 for the A10 region. For the values and the LOS result table, the Level values that Muraleetharan and his team reached during their work were accepted and a ranking was made from the lowest to the highest values with equal intervals. When the values taken for the selected region were added, it has been observed that the region is at "B" pedestrian level of service.

5.1.6.6. Gallin - Australian Method Results

Also known as the Nicole Gallin PLOS method in some sources, this method has a different weighting coefficient for each determined factor and the PLOS value is obtained by placing the sum of the results in a range in the table.

The process of determining the PLOS value starts with the determination of the LOS factors on the desktop, and then continues with the field observations and the scoring of these factors. After the score of each factor was determined, these scores were multiplied by the weighting coefficients determined in the study conducted by Nicole Gallin in Australia, and they were collected in the method and determined as a PLOS value. Results of the Australian method were shared in Table 5.28.

As Gallin determined, the worst LOS level was shown as E, and in our study, considering these score ranges, results were found between C and D levels for each region. At this point, the fact that the F value is not included in Gallin's study is an important factor. Because this tells us that the regions with D results may correspond to the E result in our 6th system, or that the C results may be D in the same way.

The Australian method examined the pedestrian path segments under 3 main and 11 auxiliary sub-headings and placed them on a scoring system from 0 to 4 for each. Values such as sidewalk width, ground quality, and obstacles were examined and noted in the field for our study. Apart from this, the pedestrian counts made for each region were evaluated daily and included in the method, and unlike other methods, it was paid attention to what percentage of the general use of the road was not pedestrian. The numerical results for all of the 10 selected regions were collected and the service level was found according to LOS table determined by the Welsh. Only “C” and “D” level of service grades were found as a result for all the regions.

Similar to the Gainesville method, measurements made in the field for the Australian Method were used in order to obtain the PLOS values. The fact that Autrallian Method has its own weightinin system with multipliers, it is observed that the most impartant factor of this method is the surface quality, followed by path width, connectivity, personal security, crossing opportunities and mix of path users. Since more than one factor affects the LOS value of the regions, it will not be very accurate to attribute the difference between regions to a single factor. Reason for the differences between regions may be dependant to difference of the surface qualities but also, for some of the regions it was observed that it caused by more than one factor such as obstructions per kilometer, crossing opportunities and support facilities.

In Australian method, it is necessary to use vehicle and pedestrian counts for two indicators. In order to exemplify this part, the A7 region was chosen. Since Pedestrian Volume takes into account the total number of pedestrians per day and the study was conducted throughout Ankara, this value was taken as “More than 350 per day” in all regions. In order to determine the percentage of segment users, vehicle and pedestrian counts were checked for each hour, and the percentage of pedestrians was determined by calculating the ratio of vehicles to pedestrians. Since in this method, a single result will be given for each region, the percentages of all dates and times were compared as minimum and maximum, and then an average value was selected. Since this value is approximately 60.1% for the selected region, the method continued to be applied by choosing "approx 51% to 70% of path users were non-pedestrian". When the coefficients were multiplied and the results were summed, the pedestrian level of service of the A7 region was found as "C".

Table 5.28. PLOS Method Outcomes for different Non-Hourly Methods

PLOS Results of Regions for Different Methods						
Location	**Disabled PLOS**	**Sarkar**	**Trip Quality**	**Gainesville**	**Conjoint**	**Australian**
A1	C	D	B	D	B	C
A2	D	F	C	D	B	D
A3	C	D	B	D	B	C
A4	D	D	D	E	B	D
A5	D	D	D	E	B	D
A6	D	D	D	D	B	D
A7	D	C	B	D	B	C
A8	D	B	C	D	A	C
A9	E	D	D	D	B	D
A10	D	C	C	D	B	D

Due to the results from Table 5.28;

- According to the Disabled PLOS method, it was observed that the better regions among others were A1 and A3, but the worst region was A9.
- According to Sarkar's PLOS method, it was observed that the best region was A8, but the worst region was A2.
- According to the Trip Quality method, it was observed that the better regions among others were A1, A3 and A7, but the worse regions among others were A4, A5, A6 and A9.
- According to the Gainesville method, A4 and A5 regions were found to be the worse regions among others.
- According to the Conjoint Analysis method, it was observed that the better region among others was A8.

- According to the Australian Method, A1, A3, A7 and A8 regions were observed to be better than other regions.

5.1.7. Traffitec Method Results

The Traffitec Method, which was produced from a study carried out in Denmark, is a study carried out with the participation of many people and surveys under normal conditions. In order to use the Equation 3.51 that emerged as a result of the study, hourly vehicle counts were taken into account, as well as hourly bicycle and motorcycle numbers. The necessary parts were selected from the counts made for 10 regions in the Metropolitan Municipality and included in the Equation 3.51.

For the method as an environmental factor, the type of surrounding area and sidewalk is also classified. In addition, attention was paid to how often there were trees on the route and how often car parks were built on the roadside. Width measurements taken during the site visit were also used for this method. Although a large survey was not conducted for the level of satisfaction, which is perhaps the most important point of the method, a value was determined by asking the opinions of the experts of the Metropolitan Municipality and the pedestrians who used the roads in the regions.

The study of the Traffitec PLOS method was carried out by Jensen (2007) by conducting a survey with more than 7000 people in total about their satisfaction levels. As a result of his studies, he created an equation to determine the PLOS level. In his study, Jensen (2007) leveled the PLOS values from A to F, with A being the best, in accordance with the PLOS levels determined by the HCM. Although Jensen (2007) have stated that LOS values were graded from A to F in his study, there is no LOS score table in the study including all the parameters used for the method. Since the main factor of the Traffitec model is the level of satisfaction and Jensen's study receives answers from every satisfaction level, it has been observed that the results obtained from the model result were compared with equal intervals between the minimum and maximum values.

When Equation 3.51 is used for the Traffitec model, making a comparison between the minimum and maximum values for each region in the results obtained means that both "A" level and "F" level will be observed for every region. At this point, as the peak result will be “F” level, it has been decided to include the results for this method by taking the average. Average values were obtained for all the regions and shown in Table 5.22. This solution method is named as Traffitec 1 in Table 5.22.

However, it was not very logical to evaluate by finding both the "A" level and the "F" level in each region. For this reason, different solution methods have been tried on the method. As a second solution method, in order to preserve the continuity with Jensen’s the minimum and maximum value method, firstly, a minimum and a maximum value were found by comparing the results found in all 10 regions. Obtained minimum and maximum values were divided equally to 6 in order to classify PLOS in 6 grades. For this solution, every region’s LOS grade were determined by the same PLOS score intervals. Both the average results and the peak results were shared in Table 5.22. This solution method is named Traffitec 2. Although this method is healthier than the first method applied, as it can be seen in Table 5.22, since regions such as Kızılay were much more crowded than other regions, it has been observed that it affects the results of all regions as they affect the minimum and maximum values found in total. In this context, even if the calculation is made considering the same day and the same time, if more regions were taken into account in the method, it is expected that all results will change.

As a third method, it is considered to use the normal distribution system so that each region can be evaluated independently from other regions. First, the mean of the model results in each region was calculated, and then the standard deviations of the regions were found by using Equation 5.1. The mean result of the region was subtracted from the model result and divided by the standard deviation. As a result, new values were determined for each time interval. This solution method is named Traffitec 3. The average results of each of the 3 solution methods were shared in Table 5.29.

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(\alpha_i - \bar{\alpha})^2}$$

Where (5.1)

s = Standard Deviation

n = Total number of results for the region

α = Traffitec model result

$\bar{\alpha}$ = Average of the Traffitec model result for the region

Table 5.29. Traffitec Model Results for 3 different solution method

Location	Traffitec 1	Traffitec 2 (Ave)	Traffitec 2 (Peak)	Traffitec 3
A1	B	B	E	C
A2	B	B	D	E
A3	B	C	F	C
A4	B	A	A	D
A5	C	A	A	E
A6	B	A	B	D
A7	A	A	B	C
A8	C	B	B	D
A9	C	A	A	E
A10	C	A	A	C

After the examination of each different 3 solutions, it was determined to use the results of the Traffitec 3 method, since the normal distribution method evaluates each region separately due to the way the method is applied. Since the normal distribution system was applied, the results were not evaluated according to the peak values, instead, the average PLOS values were used in the comparisons. Results of the Traffitec method were shared in Table 5.30, Table 5.31, Table 5.32 and Table 5.33.

A4 region was chosen to show an example of PLOS evaluation with the Traffitec method. Fixed values when examined independently of the selected date and time;

The level of satisfaction in the region was determined as “somewhat dissatisfied” by asking more than one user and it was taken as $\alpha = 0.8758$. The walking area was considered as sidewalk-concrete and $WA = 3.5486$ was taken, and the surrounding area was determined as $AREA = -1.6349$, where determined as shopping-residential mixed. The average vehicle speed was accepted as $SPEED = 51\ km/h$ found in the HCM LOS model. The number of vehicles parked along 100 meters was determined as $PARK = 16$, and $BUF = 0.6$ & $TREE = 1$ since there was a buffer in a certain part of the segment and there was at least 1 tree in 50 meters. Since the number of road lanes was 2, it was taken as $LANE = 0$ and since there was no median on the sidewalk, it was taken as $MED = 0$. On-site measurements were made, as total sidewalk width $BL = 2.5\ m$ and effective sidewalk width $SB = 1.6\ m$ were taken to be used in Equation 3.51.

When the date of 14 August 2021 was examined between 17:30 and 18:30, it was observed that the number of vehicles passing per hour was $MOT = 1022$, the number of pedestrians passing per hour was $PED = 704$ and the number of bicycles, motorcycles etc. passing hourly was observed as $BIKE = 0$. When these parameters were placed in the Equation 3.51, a value of approximately 0.678 was obtained. Since the method was based on satisfaction as the main factor in determining LOS degrees, this result does not lead us directly to a grade. For this reason, a bell curve system was made by making standard deviations between all dates and times, and the PLOS value for the specified date and time was found as "E".

Table 5.30. Traffitec Method 1st Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
19.07.2021	**A2**	B	A	A	C	D	D	A	A	C	D	F	E
	A5	B	F	F	F	F	F	F	F	F	F	F	F
	A9	A	C	D	E	F	F	F	F	F	F	F	F
20.07.2021	**A2**	B	B	B	B	A	A	A	A	A	B	B	B
	A5	A	B	B	B	C	C	C	C	C	E	F	D
	A9	A	B	B	A	E	F	E	D	F	F	F	F
21.07.2021	**A2**	B	B	B	B	A	B	A	A	A	B	B	B
	A5	A	A	A	B	B	D	D	D	D	E	F	F
	A9	A	B	B	A	E	F	E	E	E	F	F	F
22.07.2021	**A2**	B	B	B	B	A	A	A	A	A	A	B	A
	A5	A	B	B	B	B	D	C	C	D	E	F	F
	A9	A	B	B	A	E	F	E	E	F	F	F	F
23.07.2021	**A2**	C	B	B	B	A	C	F	F	F	F	F	F
	A5	A	C	C	D	E	F	F	F	F	F	F	F
	A9	A	A	A	A	C	F	E	F	F	F	F	F
24.07.2021	**A2**	B	A	A	B	D	E	F	F	F	F	F	F
	A5	A	A	B	C	C	F	F	F	F	F	F	F
	A9	A	A	A	A	A	C	D	F	F	F	F	F
25.07.2021	**A2**	A	A	A	B	C	E	E	F	F	F	F	F
	A5	A	B	C	D	D	F	E	F	F	F	F	F
	A9	A	B	A	A	A	C	D	F	F	F	F	F

Table 5.31. Traffitec Method 2nd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
02.08.2021	A2	E	F	F	F	F	F	F	F	F	F	F	F
	A5	D	F	F	F	F	F	F	F	F	F	F	F
	A9	B	D	C	B	E	F	F	F	E	F	F	F
03.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	D	F	F	F	F	F	F	F	F	F	F	F
	A9	A	C	B	C	D	E	D	F	F	F	F	F
04.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	B	F	F	F	F	F	F	F	F	F	F	F
	A9	A	B	B	C	D	E	D	E	F	F	F	F
05.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	D	F	F	F	F	F	F	F	F	F	F	F
	A9	A	B	B	C	D	E	D	E	F	F	F	F
06.08.2021	A2	E	F	F	F	F	F	F	F	F	F	F	F
	A5	E	F	F	F	F	F	F	F	F	F	F	F
	A9	B	C	C	E	F	F	F	F	F	F	F	F
07.08.2021	A2	A	B	C	F	F	F	F	F	F	F	F	F
	A5	A	F	E	F	F	F	F	F	F	F	F	F
	A9	A	B	D	E	F	F	F	F	F	F	F	F
08.08.2021	A2	A	B	D	F	F	F	F	F	F	F	F	F
	A5	B	F	D	F	F	F	F	F	F	F	F	F
	A9	A	B	D	E	F	F	F	F	F	F	F	F

Table 5.32. Traffitec Method 3rd Week Results for three different regions (A2, A5, A9)

Time	Region	Hour Intervals											
		7:30 - 8:30	8:30 - 9:30	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30	12:30 - 13:30	13:30 - 14:30	14:30 - 15:30	15:30 - 16:30	16:30 - 17:30	17:30 - 18:30	18:30 - 19:30
09.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	A	E	D	E	F	F	F	F	F	F	F	F
10.08.2021	A2	E	D	D	F	F	F	F	F	F	F	F	F
	A5	E	F	F	F	F	F	F	F	F	F	F	F
	A9	B	E	D	E	F	F	F	F	F	F	F	F
11.08.2021	A2	D	D	E	F	F	F	F	F	F	F	F	F
	A5	D	F	F	F	F	F	F	F	F	F	F	F
	A9	C	E	E	E	F	F	F	F	F	F	F	F
12.08.2021	A2	D	E	E	F	F	F	F	F	F	F	F	F
	A5	D	F	F	F	F	F	F	F	F	F	F	F
	A9	B	D	D	E	F	F	F	F	F	F	F	F
13.08.2021	A2	F	F	F	F	F	F	F	F	F	F	F	F
	A5	F	F	F	F	F	F	F	F	F	F	F	F
	A9	C	D	D	E	E	F	F	E	F	F	F	F
14.08.2021	A2	B	D	F	F	F	F	F	F	F	F	F	F
	A5	D	E	E	F	F	F	F	F	F	F	F	F
	A9	C	C	C	E	F	F	F	F	F	F	F	F
15.08.2021	A2	B	C	F	F	F	F	F	F	F	F	F	F
	A5	D	E	E	F	F	F	F	F	F	F	F	F
	A9	B	C	B	E	F	F	F	F	F	F	F	F

Table 5.33. PLOS Results by Traffitec of peak hours for 19.07.2021-15.08.2021

Time	Region	Hour Intervals			Time	Region	Hour Intervals			Time	Region	Hour Intervals		
		8:30 - 9:30	12:30 - 13:30	17:30 - 18:30			8:30 - 9:30	12:30 - 13:30	17:30 - 18:30			8:30 - 9:30	12:30 - 13:30	17:30 - 18:30
19.07.2021	A1	B	B	B	02.08.2021	A1	B	C	E	09.08.2021	A1	B	F	E
	A3	B	B	B		A3	B	D	D		A3	B	C	D
	A4	D		D		A4	E	D	B		A4	E	F	B
	A6	C	E	E		A6	F	E	E		A6	F	E	D
	A7	B	D	F		A7	B	B	C		A7	B	C	F
	A8	C	C	D		A8	E	E	F		A8	D	E	F
	A10	C	B	B		A10	A	C	C		A10	A	B	C
20.07.2021	A1	B	B	B	03.08.2021	A1	B	B	B	10.08.2021	A1	B	E	F
	A3	B	A	B		A3	B	C	E		A3	B	D	E
	A4	A	D	E		A4	E	F	D		A4	E	E	D
	A6	A	B	C		A6	F	F	D		A6	F	E	D
	A7	C	B	B		A7	B	B	C		A7	B	B	C
	A8	B	B	D		A8	E	C	F		A8	E	D	F
	A10	F	E	C		A10	A	B	C		A10	B	B	A
21.07.2021	A1	B	B	B	04.08.2021	A1	B	C	D	11.08.2021	A1	B	F	F
	A3	B	A	B		A3	B	C	E		A3	B	D	F
	A4	A	D	E		A4	E	F	E		A4	E	E	E
	A6	A	B	C		A6	E	E			A6	E	E	E
	A7	C	B	B		A7	B	B	E		A7	B	B	C
	A8	B	C	D		A8	E	D	F		A8	D	D	E
	A10	F	E	C		A10	B	A			A10	B	B	B
22.07.2021	A1	B	B	B	05.08.2021	A1	B	B	B	12.08.2021	A1	B	F	E
	A3	B	A	B		A3	B	C	E		A3	B	E	F
	A4	A	D	E		A4	E	F	E		A4	E	E	D
	A6	B	B	D		A6	E	E	D		A6	F	E	E
	A7	C	B	B		A7	B	B	C		A7	B	B	C
	A8	A	B	E		A8	E	D	F		A8	D	E	F
	A10	F	D	C		A10	A	B	C		A10	A	B	B
23.07.2021	A1	B	B	B	06.08.2021	A1	B	B	D	13.08.2021	A1	B	D	E
	A3	B	B	B		A3	B	C	E		A3	B	C	E
	A4	B	D	E		A4	E	E	D		A4	E	E	D
	A6	B	D	E		A6	F	E	C		A6	F	D	F
	A7	C	B	C		A7	B	B	F		A7	B	B	C
	A8	A	B	E		A8	E	D	F		A8	E	D	F
	A10	E	C	B		A10	A	B	D		A10	A	B	B

24.07.2021	**A1**	B	B	C	**07.08.2021**	**A1**	B	C	D	**14.08.2021**	**A1**	B	B	D
	A3	A	B	B		**A3**	B	C	E		**A3**	A	B	D
	A4	B	D	E		**A4**	E	F	D		**A4**	C	E	E
	A6	B	D	D		**A6**	D	E	E		**A6**	D	E	B
	A7	C	B	C		**A7**	B	B	B		**A7**	B	B	F
	A8	C	D	D		**A8**	D	D	F		**A8**	D	E	F
	A10	E	C	C		**A10**	B	B	B		**A10**	B	B	F
25.07.2021	**A1**	B	B	B	**08.08.2021**	**A1**	B	C	D	**15.08.2021**	**A1**	B	B	D
	A3	B	B	B		**A3**	A	B	C		**A3**	B	B	C
	A4	A	E	E		**A4**	E	E	D		**A4**	C	E	D
	A6	C	D	D		**A6**	E	F	F		**A6**	E	E	C
	A7	C	B	B		**A7**	C	B	B		**A7**	B	B	F
	A8	B	D	E		**A8**	C	C	F		**A8**	D	E	F
	A10	E	C	B		**A10**	B	B	B		**A10**	B	B	F

If exceptions were excluded, better results were observed in the first week results than in the other weeks. Apart from this, when the results were examined, no pattern was noticed between the days. When all regions were evaluated, it was observed that A2 region LOS resuls were the worst results and A10 (Dikimevi) region results were better than the other regions. Although A10 seems to be the region that has the most A result among the regions, there were also time intervals in which the region's result was observed as F level. Although there was a decrease in the number of vehicles using the route at the weekend, as the number of pedestrians increased, both the best and the worst results of the region can be observed in the 3rd week. The days when these peak values were observed were shared in Table 5.34 in order to compare with other regions.

As it can be seen from Table 5.34, even within the same day hours, big differences as LOS results were observed. When the countings were examined, no significant difference was observed. This may mean that traffitec method does not give consistent results.

Table 5.34. Traffitec Method PLOS Results on 12.08.2021 and 15.08.2021

Time		Region									
		A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
12.08.2021	**08:30 - 09:30**	B	E	B	E	F	F	B	D	D	A
	12:30 - 13:30	F	F	E	E	F	E	B	E	F	B
	17:30 - 18:30	E	F	F	D	F	E	C	F	F	B
15.08.2021	**08:30 - 09:30**	B	C	B	C	E	E	B	D	C	B
	12:30 - 13:30	B	F	B	E	F	E	B	E	F	B
	17:30 - 18:30	D	F	C	D	F	C	F	F	F	F

5.2. Comparisons of PLOS Evaluations for Selected Regions in Ankara

When all the methods were examined, it has been observed that the worst results in general were found on the 3rd week Sunday, 15.08.2021. The LOS and PLOS levels for each region with all method results on 15.08.2021 were shared in Table 5.35.

Table 5.35. LOS and PLOS results on 15.08.2021

Location	**Time**	**Method**					
	15.08.2021	**HCM LOS**	**HCM PLOS**	**Landis**	**Mozer**	**Tan Dandan**	**Traffitec**
A1	**08:30 - 09:30**	F	A	C	E	C	B
	12:30 - 13:30	F	A	C	E	B	B
	17:30 - 18:30	F	A	C	E	D	D
A2	**08:30 - 09:30**	F	A	B	E	A	C
	12:30 - 13:30	F	A	B	E	A	F
	17:30 - 18:30	F	B	B	E	A	F
A3	**08:30 - 09:30**	F	A	D	E	F	B
	12:30 - 13:30	F	A	D	E	F	B
	17:30 - 18:30	F	A	D	E	F	C
A4	**08:30 - 09:30**	F	A	B	E	F	C

	12:30 - 13:30	F	A	B	E	F	E
	17:30 - 18:30	F	A	B	E	F	D
A5	**08:30 - 09:30**	F	A	B	D	A	E
	12:30 - 13:30	F	A	B	E	A	F
	17:30 - 18:30	F	A	B	E	A	F
A6	**08:30 - 09:30**	F	A	C	E	E	E
	12:30 - 13:30	F	A	C	E	F	E
	17:30 - 18:30	F	A	C	E	F	C
A7	**08:30 - 09:30**	F	A	B	E	A	B
	12:30 - 13:30	F	B	B	E	B	B
	17:30 - 18:30	F	D	B	E	B	F
A8	**08:30 - 09:30**	F	A	D	C	F	D
	12:30 - 13:30	F	A	D	C	F	E
	17:30 - 18:30	F	A	D	C	F	F
A9	**08:30 - 09:30**	E	A	B	E	A	C
	12:30 - 13:30	E	A	B	E	A	F
	17:30 - 18:30	E	A	B	E	A	F
A10	**08:30 - 09:30**	F	A	C	E	F	B
	12:30 - 13:30	F	A	C	E	F	B
	17:30 - 18:30	F	A	C	E	F	F

Results of each selected region cen be seen according to 1 vehicle LOS method and 11 pedestrian LOS method in the Table 5.36. Vehicle LOS results performed in accordance with the HCM method were observed as F level in each region. This situation affected the LOS levels of these methods by showing itself in the Landis, Traffitec, Mozer, Tan Dandan and Gainesville methods, which take into account the vehicle counts in the regions or the LOS level determined according to HCM method.

Table 5.36. Peak LOS and PLOS Results of all Regions

Peak Results of PLOS Methods for Each Region										
Location	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
HCM Vehicle Los	F	F	F	F	F	F	F	F	E	F
HCM PLOS	A	B	A	A	A	A	E	A	A	B
Landis	C	B	D	B	B	C	B	D	B	C
Traffitec	C	E	C	D	E	D	C	D	E	C
Mozer	E	E	E	E	E	E	E	D	E	E
Tan Dandan	E	D	F	F	C	F	D	F	A	F
Disabled PLOS	C	D	C	D	D	D	D	D	E	D
Sarkar	D	F	D	D	D	D	C	B	D	C
Trip Quality	B	C	B	D	D	D	B	C	D	C
Gainesville	D	D	D	E	E	D	D	D	D	D
Conjoint	B	B	B	B	B	B	B	A	B	B
Australian	C	D	C	D	D	D	C	C	D	D

Since there was a holiday in Turkey between time intervals 19.07.2021 and 25.07.2021 where the counts were made, better results were observed compared to other weeks in Landis, Traffitec and Mozer methods, which were dependent on vehicle and pedestrian counting. Likewise, higher LOS values were obtained in some regions in vehicle LOS results. However, despite of taking into account the vehicle and pedestrian counts, no significant difference was observed for the PLOS value of Tan Dandan method.

Unlike other methods, the HCM pedestrian method calculates the PLOS value only by considering the number of people per square meter. The overall PLOS result was found to be A for the regions examined in the study, except for the A7 (Demet) region, which has a narrow effective sidewalk. In this study, no other method was observed to find the PLOS value by only considering the number of pedestrians per square meter, except the HCM method. It has been observed that the regions determined at A level by HCM were determined at E or F levels by different methods.

It was determined that the on-street parking factor, which was used in both Landis and Traffitec methods, affected positively in case of parking on the side of walkway, in the Landis method. However, this factor affected the PLOS level negatively in the Traffitec method, which was made by considering the satisfaction level of pedestrians. For this reason, it was observed that while the PLOS value was determined as B by the Landis Method in regions such as A2, A9, it was determined as E by the Traffitec method.

When the Landis Method results were examined, although different PLOS values were observed between the regions, no great differences were observed between the hour intervals within the regions. As a result of this situation, it was observed that the vehicle counts used in the method were not a significant factor for the Landis method. It was determined that the main reason for the different values in the method was the buffer width and on-street parking factor.

It has been determined as a result of the studies that the buffer factor used in Landis, Traffitec, Mozer, Trip Quality and Gainesville methods was a significant factor in determining the results of these methods. Even if there was no specific buffer in most of the regions, the PLOS level increases when a buffer was added in the equations.

When the results of Sarkar and Trip Quality methods were examined, in which the sidewalk width was not used directly, it was determined that they had similar PLOS results. Apart from these two methods, the Tan Dandan method also does not directly consider the width of the sidewalk. Although similar to Sarkar and Trip Quality results in some regions, different PLOS results were obtained. The reason for this the Tan Dandan method takes into account the distance between the sidewalk and the vehicle traffic lane. In regions such as A2, A5, A9, PLOS values were found at A level with the Tan Dandan method, while in regions such as A3 and A8, PLOS values were observed at F levels, as the distance between the traffic lane and sidewalk was shorter which can be seen in Figure 4.7 and Figure 4.12, respectively.

It was determined that obstacles on the pedestrian path have an important role in 4 of the 11 methods used to determine the PLOS values in this study. It was observed that each of the Sarkar, Conjoint, Gainesville and Australian methods takes obstruction as a factor in determining the PLOS level. When Sarkar, Conjoint and Autralian methods were examined in the A8 (Kurtuluş) region, where there were almost no obstacles on the pedestrian path, it was observed that the region has higher PLOS levels than other regions.

It has been observed that Sarkar and Trip Quality methods only focus on environmental factors. These methods evaluate PLOS values without considering pedestrian and vehicle counts and without the need for a measurement for infrastructure. When compared with other methods, it was determined that there were specific factors used only in Sarkar and Trip Quality methods. Resting places, which were only evaluated within the Sarkar method, were one of the most important factors for the method. Since high quality resting places were found only in the A7, A8 and A10 regions, it was observed that these regions have higher LOS values than other regions according to Sarkar's method. In the Trip Quality method, in which environmental factors such as lighting and transparencywere taken into account, it was observed that Kızılay regions (A1, A2, A3) have higher LOS values.

The sidewalk slope, which was used as one of the most important factors in the Disabled PLOS method, was not observed in any of the other methods. Although it does not find a direct LOS result for disabled individuals, it was observed that there were factors for disabled individuals affecting PLOS levels in Sarkar and Mozer methods.

It was observed that the Mozer and Landis methods consider vehicle road traffic lanes as an important factor in determining PLOS. It has been observed that the A8 region, which has a 3-lane road unlike other regions, has a better PLOS value in the Mozer method compared to other regions in these two methods. As a result of the studies, it was determined that improvements in PLOS levels occur when the number of vehicle lanes increases for both methods. In this case, it should be considered to increase the number of traffic lanes in possible regions in order to increase both LOS and PLOS values.

It was observed that the number of driveways factor was considered both in the Mozer and Tan Dandan methods. As a result of the studies carried out with different driveway values on the regions, improvements occurred in the Mozer method when the number of driveways was reduced, but these improvements were not observed in the Tan Dandan method. When the results obtained in the study were evaluated, no similarity was found between the Mozer method and the Tan Dandan method. It has been observed that the Tan Dandan method results vary greatly depending on the distance between the sidewalk and the traffic lane. If the number of driveways can be reduced, improvements in vehicle LOS results and Mozer PLOS results were expected.

While evaluating the LOS and PLOS results, it was observed that vehicle speeds have an effect on Traffitec, Trip Quality and Landis method PLOS results. However, in the LOS results, as the speed was increased, the LOS level increases, while it was found to be the opposite for the PLOS values. In cases where the traffic speed increased, decrease in PLOS levels were observed. Although it was a viable improvement method for vehicle LOS at points where PLOS levels were high, since the posted speeds of Ankara city roads were determined as 50 km/h, it was not considered as a solution method within the scope of this study.

As mentioned earlier, in the table, even if it gave different results even for only 1 hour in the PLOS method values made according to HCM, that value was accepted as peak and placed in the table. However, it should not be forgotten that in the HCM method, the pedestrian LOS levels of each region yield A level results when viewed on average. Although each method gave different results, it would not be wrong to think that the HCM PLOS method does not give very accurate results when this table was examined. The reason for this was that the PLOS method also looks at pedestrians with the eyes of a vehicle, just like when making vehicle LOS calculations. As long as a wide sidewalk can accommodate pedestrian capacity, it generally appears to be an A-level region according to HCM.

When the Conjoint Analysis method was compared with other methods, it was observed that it was similar to the HCM method and found the PLOS value with very few factors affecting the PLOS. Results were observed at the A level in the A8 region and at the B level in the other 9 regions. The number of obstacles on the route can be shown as the reason for this difference. When the results and the value ranges specified in Table 3.34

were examined, it has been observed that this method was more compatible in denser areas in terms of the number of pedestrians and bicycles.

When the HCM Vehicle LOS, HCM PLOS, Mozer, Conjoint and Tan Dandan methods were not considered, the following results were observed in the methods, respectively;

- B to D for A1, A3, A7 and A8 regions,
- B to E for A4, A5 and A9 regions,
- B to F for the A2 region,,
- C to D for A6 and A10 regions.

When these method results were removed from the table, it was observed that the service level results between regions become more consistent.

Although regional similarities can be seen between the methods when the Table 5.36 was examined, no method has definitely given the same results for every region with another method.

By examining the general values of the methods, better and worse regions among othersof each method were shared in Table 5.37. When the results were examined, although some regions seem to be the better region among others according to some methods, on the contrary, it was observed as the worse region among others according to other methods. This examination was provided a good example of all of the methods work differently from each other and none of them cover all the factors affecting PLOS.

While A7 was determined as the worse region among others according to HCM, it was selected as the better region among others according to Landis, Trip Quality and Australian methods. A3 region was observed as the worse region among others when the Landis and Mozer method was examined, but it was determined as one of the better regions among others when the Disabled PLOS, Trip Quality and Australian methods were examined. While the A8 region was observed among the better regions among others according to the Mozer, Conjoint, Sarkar and Australian methods, it was observed as one of the worse regions among others in the Tan Dandan method. A5 region was determined as one of the better regions among others according to the Tan Dandan method, but it was observed as one of the worse regions among others according to the Trip Quality and Gainesville method. A9 region was found as one of the worse regions among others by DPLOS and Trip Quality methods, but was observed as one of the better regions among others according to the Tan Dandan Method. Although A2 region was observed among the better regions among others according to the Tan Dandan method, it was found to be the worse region among others in the Sarkar and Traffitec methods. While A10 region was determined as the better region among others according to the Traffitec method, it was observed as the worse region among others according to the Tan Dandan method. None of the regions were observed as better region among others for Gainesville due to having only E and D level results.

Table 5.37. Better and Worse Regions According to the PLOS Methods

Methods	Better Regions	Worse Regions
HCM PLOS	Others	A7
Landis	A7	A3
Mozer	A8	A3, A4
Tan Dandan	A2, A5, A9	A3, A4, A8, A10
DPLOS	A1, A3	A9
Sarkar	A8	A2
Trip Quality	A1, A3, A7	A4, A5, A6, A9
Gainesville	-	A4, A5
Conjoint	A8	Others
Australian	A1, A3, A7, A8	Others
Traffitec	A10	A2

5.2.1. Improvement Examples and Possibilities

Considering the Australian method for the A1 region, the PLOS result was obtained as level C. According to the Table 3.37, $69 \leq LOS \leq 100$ was shown as the interval of PLOS level C. Since the A1 region has exactly 70 points, it was determined as C level from the limit value. Since the scoring system for the method was also based on observation, if the sidewalk quality was selected as “very poor” instead of “poor”, the region decrease to the “D” LOS level. However, on the contrary, when the sidewalk quality was increased, and the obstacles on the route were reduced with the environmental contributions were slightly increased, the PLOS level of the A1 region will increase to the B level.

Considering Mozer's method for the A2 region, it was observed that the peak value was E level. In the case of some improvements conducted for disabled individuals, increase in the value of many census results were observed. In addition, if the buffer width was increased to 2 meters, a great improvement was observed in the region. An improvement was observed in the area when the waiting time of pedestrians was shortened, but this solution was not used as this could worsen the vehicle LOS. To give a specific example, when the values between 17:30 and 18:30 in the counting date of 22.07.2021 were examined;

If $FD = 1$ & $WBW = 2\ m$ were taken to be used in Equations 3.14 and 3.15, it was observed that the PLOS value increased to C level.

According to Sarkar's method, for the A2 region, when rest areas were created in order to increase the comfort level, benches were located in these regions, factors were provided for protection from weather conditions, a protection was added to the bus stops, it was observed that the LOS level in the region increases from level F to level C.

The A3 region had been taken into account in order to observe improvement using the Landis method. Specifically, when the 12:30 – 13:30 hour interval of 20.07.2021 was examined, it was observed that the PLOS level increased from "D" level to "B" as a result of using only 1.7 meters of buffer in the region.

As the Tan Dandan method was dependent on only two factors other than vehicle and pedestrian counting, and it was almost impossible for a metropolitan city to change the number of driveway access, a solution has been found for this method by changing the distance between pedestrian path and vehicle road. Using this method, A4 region had been checked in order to propose an improvement. Even when the distance between the pedestrian road and the vehicle road was 0.5 meters in the region, improvement was observed for most of the counted intervals. When this value was taken as 1 meter, the F value found for the counts between 8:30 and 9:30 on 21.0.7.2021 was changed to the level A. However, when the peak value of the region was considered, this value must be taken at least 1.53 meters in order for all results to be A level.

Since the Gainesville method was almost entirely based on observation, the region A5 region, when the sidewalk was improved, a facility for pedestrians was added and greening was done on the route, the PLOS E value which was found during the studies was increased to be level B as the PLOS result.

Even if the Trip Quality method was carried out with at least 2 observers, when the A6 region was considered, only the number of trees and lighting on the route awere increased, it was observed that the PLOS D level of the route increased to the C value.

In order to improve with the disabled PLOS method, the A9 region was considered. When tactile sidewalk was added only for the visually impaired to improve the region, the LOS value of the region was increased from E to D level. In addition, if a signal was added for the crossings, this value increases to the C level. And in addition to these two, if the number of curb ramps was increased at crossings, this value would be obtainedas level B.

When the Conjoint Analysis method examined, for each region high values were obtained in terms of pedestrian level of service. Since the method was produced from a study conducted in China, it varies according to the very high numbers of people and bicycles. However, if improvement was desired, considering the A10 region, if the obstacles on the route were removed or the sidewalk width was increased to 3 meters, the result would increase from the B level to the A level. Even when the sidewalk width was below 1.5 meters and the number of obstacles increases, since the number of people and bicycles was not obtained at extrene numbers, the LOS result of the region would decrease to the C level. At this point, based on this method, if the sidewalk width was reduced and the vehicle road width was increased, increase in vehicular LOS levels were obtained.

The average for HCM pedestrian LOS levels were observed as A level for each regions. Since the method was very superficial to pedestrians, even if the sidewalk width in the A8 area was reduced from 6.65 meters to 0.65 meters, since the number of pedestrians was not observed as high numbers, most of the hour intervals still remain at the A level. And, it has been observed that this level was decreased to level B in some hour intervals when the reducement was done for the sidewalk width. In such regions, it was possible to increase to acceptable levels from F levels, by increasing the width of the vehicle road based on the HCM method.

For the HCM vehicle LOS levels, when the A7 region 24.07.2021 date and the 8:30 – 9:30 interval were considered, if the number of lanes was increased from 2 to 3, it has been observed that the level found as F increases to the level D. It was aslo observed that LOS value increased from F to E if the number of lanes was kept constant at 2 and a total of 1 meter was added to the right and left shoulder widths.

It was observed that, change made for the factors that were used in more than one method such as road lane width, afforestation on the route, buffer width, construction on the walkway also increase other method PLOS results.

6. CHAPTER

CONCLUSIONS AND FURTHER RECOMMENDATIONS

As a result of the countings made with a 3-week period in 10 different locations in Ankara, the capital city of Turkey, it was observed that more work should be done on the determination of the pedestrian road service level and the methods used to evaluate PLOS values should be developed. It has been observed that the traditional methods used to detect walkability and PLOS are insufficient and not comprehensive today. Therefore, this study was conducted as a comprehensive study as it encounters 11 different PLOS methods and 1 LOS method in one capital city. This study is important because these methods were investigated in a capital city of a country for different regions.

Through the PLOS and LOS evaluations of selected regions of Ankara pedestrian and vehicle activities, it is concluded that,

- Highway Capacity Manual (2010) vehicular LOS method is a globally accepted LOS calculation method. Only this method was used to determine the vehicle LOS for all of the regions. Almost all of the results obtained for the selected regions in Ankara were found at E and F levels. Therefore, traffic jam should be decreased and new solutions should be considered such as using intelligent transportation systems, improving highway capacities etc.
- It was observed that HCM is only considering sidewalk capacity (the number of people on the sidewalk) to determine the PLOS result. When the results were compared for different regions and times it can be highlighted that it is a quite limited method than the other methods.
- A7 (Demet) region has different result for PLOS degree when HCM method was used because of relationship between effective narrower sidewalk width and number of pedestrians. A7 has different PLOS degrees, generally, after 12:30.

However, although time intervals did not affect the results for other regions and generally, results are ‘A’, A7 region have ‘E’ result for some of the time intervals.

- As for Landis method, A2, A4, A5 and A9 regions have ‘B’ for all times. However, others can have worse PLOS degrees.
- While calculating PLOS values with the Landis method, vehicle flow rate was used instead of pedestrian flow rate in the method ehen comparing the other method. In other words, it is a pedestrian level of service technique but it uses number of vehicles instead of person. As a result, PLOS results have not much difference within each region even though the vehicle flow rates used in the method are at very high levels. However, the number of the vehicles on the on-street parking and sidewalk presence have more significant effect than flowing vehicles.
- For Landis, A3 and A8 have ‘C and D’ degrees and A7 has the better results such as ‘A and B’. A degree can be seen for only holiday mornings, but other times PLOS changed.
- Although Traffitec method formulates the PLOS analysis by considering both the vehicle and the pedestrian, the main factor determining the level is the satisfaction level of the users. At this point, this method should be more effective to obtain accurate results by applying a survey to a large number of people to ensure the accuracy of the information received from the users.
- Although good and bad LOS levels are observed in Traffitec Method for almost every region due to the application of the method, the region with the most A level was determined as A10. On the contrary, the region with the most F level was determined as the A2 region.
- The Mozer method includes many different factors and examines the PLOS results under 4 main and 3 auxiliary factors. The method also includes vehicle and pedestrian counts. It has been noticed that the method is very affected by the presence of traffic jams and for this reason, it has been determined that the number of vehicle lanes is an important factor for the method.
- For Mozer Method, due to having 3 lanes on the road and less traffic jams, A8 was selected as the better region among others with mostly C level results. A3 and A4 regions, traffic jam exist, were determined as the worse regions among others as a result of the method.

- Although Tan Dandan method uses vehicle, pedestrian and bicycle counts in PLOS calculations, when these values are changed, there was no big difference seen in the PLOS results. The factor on which the method is the most dependent was found to be the distance between the sidewalk and the car lane.
- A2, A5 and A9 regions were found to be the better regions among others according to the Tan Dandan method with A levels, while A3, A4, A8 and A10 regions were determined as the worse regions among others due to the very short distance between the road lane and the sidewalk or the absence of this distance.
- The Disabled PLOS method has different indicators than the others. Each indicator has its own multipliers determined by Asadi-Shekari et al (2013). However, it is a method that evaluates the examined area only for disabled individuals. Therefore, it should be improved for other pedestrians also.
- For DPLOS Method, Due to the lack of support for disabled people such as insufficient curb ramps, tactile sidewalk, signal at traffic lights, A9 (Pursaklar) region was determined as the worse region among others among others. A1 and A3 (Kızılay) regions were determined as the better regions among others resulting from having elevators, signals at lights and sufficient curb ramps.
- It has been observed that the Sarkar Method is a method that examines PLOS results by evaluating environmental factors only based on observation. Although very important issues such as resting areas were mentioned in the method, no counting or measurement was used in the method.
- According to Sarkar’s method, A2 (Kızılay) region was determines as worse region among others due to the lack of resting areas and physical difficulties while walking. On the other hand, A8 region (Demet) was determined as the better owing to the fact that region has quality rest areas away from the effective walkway.
- It has been determined that the Trip Quality method is a method based on environmental factors, performed with at least two different observers. Just like Sarkar's method, since it is completely observer-based, it is a method that has the potential to produce misleading results if more than two observers are not used.
- Regions A1, A3 and A7 were determined as the better regions among others in the Trip Quality method with B grade PLOS levels. Complexity of path network and spaces can be shown as the biggest reasons for this rating.

- When the Conjoint Analysis method was examined, it was observed that PLOS values were found by evaluating only 4 different categories and 3 different levels. As a result of the studies, it has been understood that the method will give more accurate results in denser regions or cities than selected regions in this study.
- While B-level results were observed in every other region, PLOS level was determined as A in the A8 (Kurtuluş) region due to the absence of obstacles on the route and a wide sidewalk width.
- For the Australian method, a score and weight systems are used to determine the PLOS levels. After scoring many different factors of the Australian Method from 0 to 4, afterwards LOS grade was obtained by multiplying each different factor by its own weight and summing the results. Although vehicle and pedestrian counts are not taken directly in the method, daily pedestrian volume and potential vehicle conflicts are included.
- Australian method results were similar to Trip Quality results, and C level results were observed in A1, A3, A7 and A8 regions. In other regions, this result examined as level D.
- In HCM pedestrian, Landis, Traffitec, Mozer methods, the PLOS result was found by considering the general structure of the sidewalk within the method. Any improvement on the sidewalk may improve the PLOS results of the regions.
- Since the number of vehicle road lanes are included in the Landis and Mozer method, if the number of lanes is increased in the appropriate regions, improvements in the Landis and Mozer method results can be observed.
- When the results of the HCM pedestrian and Conjoint method are evaluated, it is observed that depending on these results, improvements such as adding lanes or increasing the road width to increase the vehicle LOS is possible.
- Although Ankara is shown to be at acceptable levels in some regions in terms of walkability, it is not at the best level and there is a need for improvement in general. Since the vehicle service level is at poor levels, improvement is needed to increase vehicle transportation efficiency.
- Although some indicators are similar within the methods, all indicator are not included in one method. All of the methods work differently from each other and none of them cover all the factors affecting PLOS. Therefore, different results were observed for each method.

- Although regional similarities can be seen between the methods, no method has definitely given the same results for any region with another method.
- In the method results, the regions were determined as better than others according to some methods and worse according to others. Inconsistency was observed between the methods.
- Results obtained in the first week observerved to be better PLOS levels due to the holiday in Turkey. In general, the lowest PLOS levels were observed on Sundays of the 3rd week.
- Lower PLOS levels were observed on weekends compared to weekdays according to HCM PLOS and Landis methods. No such inference was made in other methods.
- During the holiday week, higher results can be observed on the Monday of the first week compared to other weekdays in the methods.
- In non-holiday weeks, for weekdays, lower PLOS results were observed on Mondays and Fridays, compared to Tuesday, Wednesday and Thursday.
- Although the peak hours were determined for the regions, when the methods were examined, higher PLOS results were observed in the morning hours compared to the noon and evening hours when the Traffitec method was excluded. Likewise, lower PLOS results were observed in the evening hours compared to the noon results.

It was observed in this study that all methods used to evaluate PLOS was developed in accordance with the region where the method was studied. For this reason, there are inconsistencies between the methods. In order to eliminate such inconsistencies, a comprehensive PLOS table can be created and before each PLOS study conducted, a questionnaire can be made to the path users to rank the priorities of the features in the new methods. For a new future study, the priority order of the pedestrians that use the walkway, regardless of the region where the study is carried out, can be determined and an adjustment factor can be created for each reagion to be studied. These adjustment factors can act as a weight just as used in the Australian Method. A score can be given to each criterion and the results can be obtained by multiplying the scores with weights. Questionnaires can be made to large groups of local pedestrians before each study.

Adjustment factors can be adjusted according to each region to be studied. An example table prepared for this approach was shown in Table 6.1.

Table 6.1. Example PLOS Evaluation Sheet

Indicators	**Priorities**	**Priority Adjustment Factor**	**Scores**			**Results**
Level of Satisfaction for the roadway						
Walkway Width						
Effective Walkway Width						
Buffer Width						
On Street Parking Percentage						
Running speed of vehile traffic						
Continuity of the sidewalk						
Slope of the Sidewalk						
Precense of the Signals at Crossings						
Precense of the Curb Ramps						
Precense of the Tactile Pavement						
Complexity of the Path Network						
Building Articulation						
Number of Driveway Access						
Vehicle LOS Value						
Pedestrian Flow Rates						
Provided Support Facilities						
Obstructions on the walkway						
Precense of the Rest Areas						
Protection from weather conditions						
Green Areas Around the Walkway						
Noise Levels						
Surface Quality						
Personal Security Levels						
Shade Trees						
Path Environment						
TDM/Multi Model Support						

More comprehensive studies on PLOS can be carried out and more indicators can be added to the new table. Also, in order to obtain more accurate PLOS results, factors such as flow rate and other counting dependant factors can be removed from the table and used with a separate equation.

For the metropolitan cities, in their future transportation plannings, both highway and sidewalk level of services should be determined and improved with analyzes using intelligent transportation systems that include a lot of elements such as number of cars and pedestrains and environmental factors.

REFERENCES

Al-Suleiman, T. I., Reinforced Soil, J., Pernia, J. C., John Lu, J., Petritsch, T. A., Mead, S., McComb, P., Jackson, A., Armstrong, K., Connell, J., Hampapur, A., Karnin, E., Linsker, R., Ramaswamy, G. N., Ratha, N. K., Senior, A. W., Snowdon, J. L., Zimmerman, T. G., & Zabyshny, A. A. (2001). Operational Characteristics of Inline Skaters. In Transportation Research Record (Vol. 1773). http://www.tfhrc.gov/safety/pedbike/

Archana, G., & Reshma, E. K. (2013). ANALYSIS OF PEDESTRIAN LEVEL OF SERVICE FOR CROSSWALK AT INTERSECTIONS FOR URBAN CONDITION. In International Journal of Students Research in Technology & Management (Vol. 1, Issue 06). www.giapjournals.com/ijsrtm/

Asadi-Shekari, Z., Moeinaddini, M., & Shah, M. Z. (2013). Disabled pedestrian level of service method for evaluating and promoting inclusive walking facilities on urban streets. Journal of Transportation Engineering, 139(2), 181–192. https://doi.org/10.1061/(ASCE)TE.1943-5436.0000492

Asadi-Shekari, Z., Moeinaddini, M., & Zaly Shah, M. (2013). Non-motorised Level of Service: Addressing Challenges in Pedestrian and Bicycle Level of Service. In Transport Reviews (Vol. 33, Issue 2, pp. 166–194). https://doi.org/10.1080/01441647.2013.775613

Asadi-Shekari Z., Moeinaddini M., Shah M.Z. 2014. A pedestrian level of service method for evaluating and promoting walking facilities on campus streets. Land Use Policy, 38, 175–193. doi: https://doi.org/10.1016/j.landusepol.2013.11.007

Bivina G.R, Parida P., Advani M., Parida M. 2018. Pedestrian Level of Service Model for Evaluating and Improving Sidewalks from Various Land uses. European Transport \ European Transport, Issue 67, Paper No. 2, ISSN 1825-3997.

Christopoulou, P., & Pitsiava-Latinopoulou, M. (2012). Development of a Model for the Estimation of Pedestrian Level of Service in Greek Urban Areas. Procedia - Social and Behavioral Sciences, 48, 1691–1701. https://doi.org/10.1016/j.sbspro.2012.06.1144

Dixon, L. B. (1990). Bicycle and Pedestrian Level-of-Service Performance Measures and Standards for Congestion Management Systems.

Dowling, R. (2008). Multimodal Level of Service Analysis for Urban Streets: Users Guide National Cooperative Highway Research Program.

Frackelton, A., Grossman, A., Palinginis, E., Castrillon, F., Elango, V., & Guensler, R. (2013). Measuring Walkability: Development of an Automated Sidewalk Quality Assessment Tool. Suburban Sustainability, 1(1). https://doi.org/10.5038/2164-0866.1.1.4

Gallin, N. (2001). Quantifying pedestrian friendliness guidelines for assessing pedestrian level of service (Vol. 10).

Jaskiewicz, F., Jackson, G., Anglin, K., & Rinehart, L. (2000). Pedestrian Level of Service Based on Trip Quality.

Jensen, S. U. (2007). Pedestrian and bicyclist level of service on roadway segments. Transportation Research Record, 2031, 43–51. https://doi.org/10.3141/2031-06

Karatas P., Tuydes-Yaman H. 2018. Variability in Sidewalk Pedestrian Level of Service Measures and Rating. Journal of Urban Planning and Development, Volume 144, Issue 4. doi: https://doi.org/10.1061/(ASCE)UP.1943-5444.0000483

Landis, B. et al (2001). Modeling the Roadside Walking Environment Pedestrian Level of Service. In Transportation Research Record.

Maddock JE, Ramirez V, Heinrich KM, Zhang M, Brunner IM. 2012. A state wide observational assessment of the pedestrian and cycling environment in Hawaii, 2010. Preventing Chronic Disease, 9:110096. DOI: http://dx.doi.org/10.5888/pcd9.110096

Mozer, D. (1994) "Calculating Multi-Modal Levels-of-Service (Abridged)." International Bicycle Fund, http://www.ibike.org/lcs.htm.

Muraleetharan, T., Adachi, T., Uchida, K.-E., Hagiwara, T., & Kagaya, S. (2004). A Study on Evaluation of Pedestrian Level of Service along Sidewalks and at Intersections Using Conjoint Analysis.

National Research Council (U.S.). Transportation Research Board. (2000). Highway capacity manual. Transportation Research Board, National Research Council.

Petritsch, T. A., Landis, B. W., McLeod, P. S., Huang, H. F., Challa, S., Skaggs, C. L., Guttenplan, M., & Vattikuti, V. (2006). Pedestrian level-of-service model for urban arterial facilities with sidewalks. Transportation Research Record, 1982, 84–89. https://doi.org/10.3141/1982-12

Sarkar, S. (2003). Qualitative Evaluation of Comfort Needs in Urban Walkways in Major Activity Centers. Transportation Quarterly, 57.

Sdoukopoulos E. 2011. Methodologies for assessing the pedestrian Level of Service: International experience and adjustment to the Greek walking environment – The case of Thessaloniki. Conference: Young Researchers Seminar at Copenhagen, Denmark.

Singh K. and Jain P.K. 2011. Methods of Assessıng Pedestrıan Level of Service. Journal of Engineering Research and Studies. Vol. II, Issue I, 116-124.

Sisiopiku, V., Byrd, J., & Chittoor, A. (2007). Application of Level-of-Service Methods for Evaluation of Operations at Pedestrian Facilities. Transportation Research Record, 2002, 117–124. https://doi.org/10.3141/2002-15

TAN, D., WANG, W., LU, J., & BIAN, Y. (2007). Research on Methods of Assessing Pedestrian Level of Service for Sidewalk. Journal of Transportation Systems Engineering and Information Technology, 7(5), 74–79. https://doi.org/10.1016/S1570-6672(07)60041-5

Wibowo S. S., Destri Nurhalima R. M. 2018. Pedestrian facilities evaluation using Pedestrian Level of Service (PLOS) for university area: Case of Bandung Institute of Technology. MATEC Web of Conferences 181, 02005. doi: https://doi.org/10.1051/matecconf/201818102005

APPENDIX

APPENDIX 1 – Count Data Sheet used for regions other than A9

Place			
Date		Time Interval	

			Direction							
			Person		Vehicle					
			Male&Female	Disabled	Normal	Truck	Bus	RV	Bike	Bicycle
1 Hour	15mins	3mins								
		3mins								
		3mins								
		3mins								
		3mins								
	15mins	3mins								
		3mins								
		3mins								
		3mins								
		3mins								
	15mins	3mins								
		3mins								
		3mins								
		3mins								
		3mins								
	15mins	3mins								
		3mins								
		3mins								
		3mins								
		3mins								

APPENDIX 2 – Count Data Sheet used for region A9

Place			
Date		Time Interval	

			Direction1								Direction2					
			Person		Vehicle						Vehicle					
			Male & Female	Disabled	Normal	Truck	Bus	RV	Bike	Bicycle	Normal	Truck	Bus	RV	Bike	Bicycle
1 Hour	15mins	3mins														
		3mins														
		3mins														
		3mins														
		3mins														
	15mins	3mins														
		3mins														
		3mins														
		3mins														
		3mins														
	15mins	3mins														
		3mins														
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		3mins														
	15mins	3mins														
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		3mins														
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