ADDIS ABABA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

POST GRADUATE STUDIES

Assessment of Pedestrian Overpass Facilities along the Addis Ababa Ring Road

By

Tilahun Haile

A Thesis Submitted to the School of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering (Road and Transport Engineering)

Advisor
Dr. Bikila Teklu (PHD)

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Addis Ababa, Ethiopia

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DECLARATION

I, Tilahun Haile, declare that this thesis titled "***Assessment of Pedestrian Overpass Facilities along the Addis Ababa Ring Road***" is my own work. I confirm that it had not been presented to any other institution for assessment or award of any certificate, diploma or degree except at Addis Ababa Institute of Technology. Information from other sources are acknowledged properly both inside the text and in the reference list.

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ABSTRACT

Among the different modes of transport, walking dominates the modal split of daily trips in Addis Ababa, making up more than 62% of total trips. Despite this, most of the streets lack crossing facilities and footways and the problem is reflected with the number of traffic accidents which is increasing by 12% every year. Walking suffers from unsafe crossing points particularly along the Addis Ababa Ring Road with no pedestrian priority with posted speed limit of 50-80km/hr and very high probability of fatality, wide carriageway separated by barriers to discourage at-grade crossing and encourage mobility with high speed and the act is stated 'illegal' and punishable, pedestrians avoid to use overpasses and take the risks of jaywalking. Most researches about the city's transport problem focus mainly on motorized traffic and neglect walking mode.

The aim of this study is to assess the rate of utilization, location appropriateness, spacing, accessibility, capacity and level of service (LOS) of pedestrian overpasses along the Addis Ababa Ring Road. The study also enquires weather the overpasses can accommodate if all non-user pedestrians at different range of distance would have used it or 100% utilization is sustained. Seven overpasses along the Megenagna-Hana Mariam Road were selected. Guideline from HCM2000 was used to determine the PLOS based on three flow rate (V_P), average pedestrian space/area (A_P) and volume to capacity ratio (V/C). Primary data like pedestrian count crossing the Ring Road every 15-minutes, questionnaire survey for overpass users and non-users and field observation and measurements are used.

In this study, 103,342 pedestrians were observed while crossing the Ring Road out of which 92,824 (89.8%) were legal and 10,518 (10.2%) illegal. The observation was made within 200m range of distance from the facilities in both sides including along the overpasses for three different weekdays at each site. A total of 1,083 questioner was distributed to 840 overpass users and 223 non-users out of which 1,063 responded fully and 20 failed to complete the questionnaire. Utilization rate was analyzed by considering non-user pedestrians crossing the Ring Road within 100m (Case-I) and non-users within half distance of the next facility in both sides (Case-II).

The maximum and minimum rates were observed at St. Yoseph overpass (OP-4) and Saris Addisu Sefer (OP-5) in case-I and Hayat Hospital (OP-2) and Nyala Motors (OP-1) in case-II with 94.61%, 83.89%, 81.49% and 45.09% utilization rates respectively. Time saving, lack of awareness, absence of law enforcement and the facility being far from their origin/destinations are main reasons that made most pedestrians not to use overpasses. The overpasses are capable of accommodating all users plus non-users within up to half distance of the facilities with a PLOS-A, B or C. They fulfill a basic area for standing ($0.3m^2$) and an area to evaluate pedestrian facility ($0.75m^2$) as a buffer zone. A v/c ratio of less than 1.0 was found implying that they serve well below capacities. The overpasses take twice of the time required to cross the Ring Road at grade level.

Key Words: Pedestrian Overpass, Pedestrian Level of Service, Utilization Rate, Measure of Convenience

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CHAPTER - 1

INTRODUCTION

1.1 Background of the Study

As pedestrians are part of every roadway environment, consideration is vital to their presence during the planning and design of all transportation projects through provision of efficient pedestrian access, safe and convenient crossing facilities and attractive walkways. Pedestrians are an integral part of any transportation system and if the entire transportation system is to function efficiently, planning for the needs and expectations of people who walk is a must (MAG, 2005).

It is unquestionable that the purpose of providing different pedestrian crossing facilities along urban roads is to enhance the safety of pedestrians and increase the operational efficiency of roads for vehicular traffic. Pedestrian safety is among one of the largest worries in the transportation and traffic engineering profession especially where walking mode of transport takes the dominant share. Many treatments have been developed and implemented to improve pedestrian safety in line with minimized interruption to motorized traffic flow. Though expensive, pedestrian overpass is regarded as the best pedestrian treatment that totally separates the two modes by space so that un-interrupted flow is maintained. It contributes to safe road crossing activity and facilitation of high speed drive especially if the road is protected to pedestrian access by guard rail and fences.

Regardless of the fact that pedestrian's safety is more guaranteed while using road crossing facilities, the utilization of these facilities is always in question and may not be welcomed by all users. This problem of not utilizing the pedestrian facility while crossing roads can be traced back to different reasons such as inconvenience of the facility, low level of service of the facility at peak periods, large spacing between crossing facilities or insufficiency to satisfy crossing demand, safety, security, etc.

Among the different types of pedestrian crossing facilities known for their separation of the two modes of traffic is pedestrian overpasses which is categorized under grade separated pedestrian crossing (GSPC). According to E.A. Axler (1984), GSPC facilities have advantages over alternative solutions of preventing pedestrian-vehicle conflicts since:

- There is no roadway capacity loss or vehicle speed reduction resulting from use of an existing GSPC compared with the other alternatives such as at grade crossings like zebra crossing. Pedestrians and vehicles have their own right-of-way instead of sharing a portion of the roadway.
- GSPCs eliminate conflicts between vehicles and pedestrians when utilize by pedestrians.

- Total delay for pedestrians and motorists can be reduced in many cases. Although pedestrians' crossing time may increase if they have to ascend and descend GSPCs ramps or steps, pedestrians no longer have to wait for gaps in vehicular traffic. Vehicles do not have to slow down or stop for pedestrians.

Despite these advantages, certain factors may prevent it from being effectively utilized by pedestrians. In this study, the rate of utilization, level of service or performance, location appropriateness, accessibility, spacing, design and capacity of seven pedestrian overpasses along the Ring Road in Addis Ababa, the capital city of Ethiopia, was assessed by considering pedestrians crossing using overpasses and illegally within a different range of distance (100m in both sides and up to half distance of the next facility). The study has also figured out the measure of convenience (R) of the facilities and identified major factors for not using the facilities, perception of pedestrians (both users and non-users) towards the overpasses through a questionnaire. The study considers seven pedestrian overpasses along the road passing through Megenanga-Bole-Saris-Kality-Hana Mariam which is part of Addis Ababa City Ring Road built mainly for mobility.

These pedestrian overpasses are provided along a road characterized by high speed traffic (with posted speed limit 50-80km/hr) and very high probability of fatality, wide carriage way (four lanes), fully protected from pedestrian access by concrete barriers and metal fences and considerably high motorized traffic volume. As a way of assessing these overpasses, pedestrian level of service (PLOS) at peak hours was computed using the methods on Highway Capacity Manual (HCM2000). The LOS of each overpasses was computed to evaluate whether their capacity and effective width is sufficient enough to accommodate users and also if non-user pedestrians within different range of distance are totally diverted to the overpasses (100% utilization rate). Finally recommendations regarding improvement measures (to reduce the problem that pedestrians face, curb the problems that pedestrians themselves create, enhance the utilization rate of the facilities) are made after identifying hindering factors for underutilization from pedestrians responses gathered through a questionnaire survey.

1.2 Statement of the Problem

Among the different modes of transport, walking takes the lions share especially in cities like Addis Ababa, the capital city of Ethiopia. According to TRL (2012), non-motorized traffic, particularly walking dominates the modal split for daily trips in the city, making up approximately 62% of total trips. Despite this, there is poor provision with over 60% of the street network lacking footways and the walking mode suffers from unsafe crossing points particularly along the Addis Ababa Ring Road with no pedestrian priority in which the poor provision of facility is reflected in the number of road accidents increasing by 12% per year (TRL, 2012). Pedestrian safety is the primary concern in designing and managing street crossings that are safe, easy to use and well-marked to support pedestrian friendly environments and link both sides of the street physically and visually. Nowadays a number of engineering solutions have been devised to accommodate pedestrians in urban transport systems like pedestrian overpasses along high-speed roads or freeways.

Along the Addis Ababa Ring Road, under difficult traffic and roadway conditions with posted speed limit of 50km/hr-80km/hr and 85 – 100% probability of fatality (from speed vs pedestrian fatality rate study by Ben W. et al. (2015)), wide carriageway separated by a long and continuous fences/barriers to discourage at-grade crossing and the road primarily built for mobility where traffic volume is very high, the act is stated as illegal and punishable, pedestrians avoid to use overpasses while crossing. A study by Sascha D. et al. (2014) had revealed that 1 out of 6 pedestrians cross the Addis Ababa Ring Road without overpasses and pedestrians perceive that overpasses take 3 times more time than the at grade crossing (jaywalking). These results were reached up on while the paper by Sascha D. et al. (2014) has a lot of gaps which are mainly of three.

- The study is mainly about a single overpass at Nyala Motors which is the only ‘legal’ means of crossing the Ring Road between *Megenagna* and *Imperial junction*. This is a very weak approach as it fails to consider other overpasses along the Ring Road which may not reveal the actual conditions elsewhere along the road.
- The utilization rate and time comparison of the two crossing alternatives (overpass vs at grade) was used as the only means of performance measures and the study fails to determine the level of service (LOS) of the facility which is the best and commonly adopted method.

- The sample size is very small and its determination does not follow a statistical approach: 24 people were interviewed (12 users and 12 non-users) and a total of 15 pedestrians were observed to record crossing times while using the two alternatives (Overpasses Vs at grade).
- Duration and counting procedures is not stated: the count was held between Megenagna and Nyala Motors overpass only and does not consider jaywalk between Nyala Motors and Imperial junction on the right side.

The problem is exacerbated by the speed of vehicles making it difficult to obtain a gap and barriers and fences installed to prevent access to pedestrians. Areas through which the road passes, it is a common scenario that overpasses meant for pedestrian crossing are spaced far apart, which may force the elderly, the handicapped, the weak and child pedestrians to walk long distance to cross over from one side of the road to the other or put them in to a risky option (jump over barriers). The Megenanga-Bole-Saris-Kality-Hana Mariam road, which is part of the Addis Ababa Ring Road, the study area, is selected for entertaining the above problems.

These problems inspired the researcher to question the rate of utilization, level of service and performance, location appropriateness, spacing, accessibility, design and capacity of pedestrian overpasses so that feedback for possible remedial measures depend on sound studies like this one.

This study is intended to address the gaps identified from previous works and problems exhibited in the field (fig 1.1) by incorporating seven overpasses with systematic and broader approach such as location appropriateness, accessibility, spacing and level of service of the facilities by implementing a genuine procedures to collect the necessary data required for the analysis cases stated in the **methodology** part in detail.

- Seven pedestrian overpasses were considered so that the actual conditions along the study route could be revealed; selecting only a single overpass at Nyala Motors is a very weak approach as it fails to consider other overpasses which may not reveal the actual conditions elsewhere along the road.
- In addition to utilization rate and time comparison of the two crossing alternatives (overpass vs at grade) as means of performance measure, this study determines the level of service (LOS) of the facilities which is the best and commonly adopted method to assess pedestrian facilities.
- The sample sizes were determined following statistical procedures unlike the previous work to record crossing times while using the two alternatives (Overpasses Vs at grade).

Figure 1.1: Pictures to Exhibit the Problem along the Study Route (Addis Ababa Ring Road)

1.3 Objective of the Study

1.3.1 General Objective

The general objective of this study was to investigate how pedestrian overpass facilities are accommodating and serving the walking mode of transport along the adjacent areas of the Addis Ababa Ring Road.

1.3.2 Specific Objectives

The specific objectives of this study are categorized in to the following four main portions.

1. To evaluate the utilization rate of pedestrian overpass facilities along the study route.
2. To evaluate the performance of the pedestrian overpasses along the study route.
3. To assess the spacing, design, location appropriateness, accessibility and capacity of the overpasses along the study route.
4. To recommend improvement measures for the accommodation, safety and convenience of pedestrians along the Addis Ababa Ring Road.

1.4 Research Questions

In cities like Addis Ababa, where walking is the principal mode of transport, pedestrians are provided crossing facilities one of them being a pedestrian overpass though the utilization, location appropriateness, spacing, performance, capacity and level of service, accessibility and design issues remain doubted. Therefore, this study is designed to address the following four research questions.

1. How does the utilization rate of pedestrian overpass facilities along the Megenanga-Bole-Saris-Kality-Hana Mariam Ring Road be characterized?
2. Is the performance of the pedestrian overpass facilities along the study route sufficient enough to accommodate all pedestrians and meet the diverse pedestrian requirements?
3. Does the design, spacing, capacity, accessibility and location of the overpasses along the study route meet the needs of pedestrian while crossing the Ring Road?
4. What are the major factors affecting pedestrians for not using the facilities and what possible remedial measures could be recommended to improve the safety of pedestrian, rate of utilization and performance of the overpasses along the study route?

1.5 Significance of the Study

Evaluating pedestrian overpass facilities along the study route is important for the following main reasons.

- To determine whether specific aspects of the overpasses are detracting from the overall walking experience and hence inhabiting use of the facility.
- To determine how well the overpasses are full filling their intended level of service.
- To assess the performance or level of service of existing pedestrian overpass is important to ensure that the facility is able to service the needs of handicapped, elderly and child pedestrians.
- Other than advancing knowledge, the findings could be a significant input for future plans in the city regarding provision of this kind of pedestrian treatment by extracting best practices made in the review part.
- Assessing the existing facilities would greatly help for future plans by revealing the hindering factors related with pedestrian's experience of crossing activity. This is necessary because, crossing demand and the current capacity of the facility may not be the same during the initial years of its provision.

In general, this study will help to motivate further investigation by any stakeholder for supplementary actions, provide contributions for policy development and decision-making in the planning process, assist as reference material, can be used for educational purpose, and foremost contributes knowledge on overpass facilities.

1.6 Scope and Limitations of the Study

1.6.1 Scope of the Study

The study is conducted in particular context of assessing the utilization rate, factors for poor utilization, location appropriateness, spacing, design, accessibility, capacity and level of service of seven pedestrian overpass facilities in Addis Ababa provided along the Megenanga-Bole-Saris-Kality-Hana Mariam Ring Road. This route is selected for the fulfillment of the following characteristics that puts no options for pedestrians other than crossing by overpasses or take the risks of jaywalking.

- High speed of motorized traffic with posted speed limit of 50km/hr and 80km/hr for two outer carriageways and two inner carriageways respectively.
- Full pedestrian access control by metal fences and concrete barriers along the road.
- Very high probability of fatality of pedestrians if struck by vehicle,
- Wide roadway width with four carriageways each separated by concrete barriers and metal fences
- Significantly high volume of motorized traffic and the road prioritizing mobility not access

- No other means of crossing the road within 100m from the overpasses.
- The act of jaywalking (jumping over barriers/ fences to cross the road) is stated 'ILLEGAL' and punishable.

1.6.2 Limitations of the Study

The highway capacity manual (HCM2000) is the only viable way found to assess the level of service of the overpasses under investigation as there are no local manuals and guidelines. Using the HCM2000, which is adopted for traffic pattern in developed countries, can be considered as the limitation of this study because the pedestrian body dimension (Human Ellipse), the traffic composition and behaviour of pedestrians in case of Addis Ababa might be different from that of Western Pedestrians.

1.7 Organization of the Paper

This thesis paper is organized in to five chapters composed of different topics as outlined below.

Chapter-1: Introduction: - Provides background of the study, defines the research problem and sets out objectives of the study. It is also composed of a set of research questions to be answered from the findings and the significance of the study. The chapter also discusses the scope and limitations of the study. Finally, the organization of the paper planned to accomplish the objective is outlined in this chapter.

Chapter-2: Literature Review: - Gives basic concepts related with pedestrian crossing facilities and pedestrian overpasses in particular. Pedestrian overpass warrants adopted for different countries were also investigated from manuals. Utilization and LOS concepts and methods adopted for assessment of pedestrian facilities were reviewed from different sources especially HCM2000. The chapter also contains reviews of previous studies related with pedestrian facility utilization and LOS analysis.

Chapter-3: Methods, Materials and Procedures: - This chapter defines the study area, methods and materials used to collect data and the details of analysis methods used in this research. The chapter also discusses the materials and procedures used for both data collection and analysis in detail.

Chapter-4:- Analysis, Results and Discussions: - This chapter provides findings in relation to objectives set out at the beginning, discussions and interpretation of the results. The chapter is concerned with utilization rates and level of service of the overpasses along the study road, factors for poor utilization and performance gathered from respondents and remedial measures to improve the hindering factors related with overpass utilization.

Chapter-5:- Conclusions and Recommendations**:-**The last chapter reviews the research objectives and questions that set out the study at the beginning. The findings as per the objectives have been documented here. The limitations and lastly strong recommendations to curb the problem have been listed out here.

CHAPTER – 2

LITERATURE REVIEW

2.1 Pedestrian Accommodation in Transportation Systems

Walking as a mode of transport is unavoidable and absolutely essential in attaining sustainability from mobility point of view. As a mode of transport, walking assists in solving traffic congestions, reducing air pollution, fuel consumption and effects on environment, access areas which cannot be accessed by motor vehicles. Cities of the developing world are rapidly urbanizing spatially, demographically and economically leading to increased pedestrian flow which calls for transport planners to provide infrastructure to facilitate this nature of movement. Walking as one of the modes of transportation demands the attention of transport and city planners, transport engineers and stakeholders as does other modes of transport.

Unfortunately, this mode of transport is not prioritized especially in developing countries irrespective of the fact that it requires inexpensive measures to invest in as compared to other modes (John M., 2015). The higher involvement of pedestrians in RTA may have been simply due to increased exposure i.e more people making walking trips. It is therefore not surprising, that they constitute the road user group appearing most frequently amongst those injured and killed. A study to compare the risks of travel in the EU countries by the four main modes and by different means of road travel had revealed that, compared with a person in a car, a person on foot is 9 times more likely to be killed for each kilometer travelled; and a person on a bicycle 8 times more likely (WHO, 2004: pp.21). The need to accommodate pedestrians and ensuring care and concern for varied users including the disabled, old persons and children is a growing challenge in most towns and cities.

So far, a number of innovative engineering solutions have been devised to accommodate and safeguard pedestrians in urban transport systems. According to Tianjiao W. (2012), in terms of how pedestrians and motorized traffic are separated, those solutions mainly fall into two categories: full segregation, such as overpasses and underpasses, and partial segregation, such as at-grade pedestrian crossings. WHO (2004) puts that the safety of pedestrians can be achieved through area-wide road safety management that includes:

- Networks of segregated/ separate pedestrian routes connecting to a public transport system are the ideal. Pedestrians have twice the risk of injury where they are not separated or segregated from motor vehicle traffic.

- Traffic-calming measures discourage motorized traffic from travelling at speeds that put pedestrians at risk.

The needs and characteristics of pedestrians can be classified into two categories namely; the physical need that deals with the body and quantitative aspects of the human and psychological need that focuses on the qualitative and conceptual aspects of the human (John M., 2015). The psychological needs of pedestrians consists of five items listed below:

1. ***Continuity:*** pedestrians are psychologically inclined towards the continuous networks without interruption,
2. ***Shortness:*** pedestrians are sensitive to distance compared to drivers and they pick the shortest route,
3. ***Beauty and Attractiveness:*** based on the fact that if the facility is attractive, more people will use it.
4. ***Security and Safety:*** refers to vulnerability during quiet times and;
5. ***Accessibility and Comfort:*** referring to the condition that an accessible and comfortable route usually encourages walking. These elements have significant influence on ***level of utility*** of pedestrian facility.

Pushkarev (1975 cited in Maina M., 2004, pp.29-30), also provides the systematic procedure that needs to be followed while planning for pedestrians which involves the following three steps:

1. ***Travel Demand Analysis:*** includes understanding pedestrians, nature of their movements, their origins- destinations, travel times, daily cycles, directional distribution and trip lengths and purposes. This helps the planner to have an accurate estimation of pedestrian densities and also a thorough understanding of pedestrian preferences and choices. An understanding of environmental influences is also important knowledge;
2. ***Calculation of pedestrian space requirements:*** which involves calculation of the space demanded by the pedestrians of a particular area depending on their densities, volumes and also existing planning standards.
3. ***Implications for Design:*** Armed with this information, the planner can proceed to provide for the pedestrians in the urban framework. He can therefore designate the facilities space to be provided for the pedestrians.

In general, provision of pedestrian infrastructures within cities need to be inclusive by considering the different aspects discussed above. But, the desired results are not always achieved due to different factors such as poor provision like design problems, large spacing of facilities, disobedience by users, ignorance of the disabled and elderly and location inappropriateness of facilities. One of the challenges this days on pedestrians can be witnessed from different RTA statistics from different sources as reviewed below from global to local.

2.2 Overview of Road Traffic Accident

2.2.1 Global Perspective

Of the estimated 1.25 million people killed by road traffic crashes each year, over 90% occur in low and middle-income countries, with only 48% of the world's registered vehicles (WHO, 2015). Almost half of those who die in road traffic are pedestrians, cyclists or users of motorized two wheelers-collectively known as vulnerable road users with high representation in developing countries (WHO, 2015). Unfortunately, RTA is a number one cause for the death of productive youths aged 15-29 years. About 62% of reported road traffic deaths occur in 10 countries with 56% of world's population -which in order of magnitude are India, China, USA, Russia, Brazil, Iran, Mexico, Indonesia, South Africa and Egypt; however, based on modeled numbers, the 10 countries with the highest number of deaths are China, India, Nigeria, USA, Pakistan, Indonesia, Russia, Brazil, Egypt and Ethiopia (WHO, 2015).

A prediction made by WHO (2004), shows that between 2000 and 2020, road traffic deaths will decline by about 30% in high-income countries but increase by 80% in low and middle-income countries. Regardless of its 4% world's registered vehicle ownership, per vehicle traffic fatality rate in African countries exceed 10%. Pedestrians constitute 22% of all road deaths worldwide, more than 40% on African roads and more than 50% in Middle Eastern countries (Sayer and Palmner, 1997; Greg C. et al., 2009; WHO, 2013). Key risk factors for pedestrian, according to WHO (2013), are vehicle speed, alcohol, lack of safe infrastructure for pedestrians and inadequate visibility of pedestrians. The report also states that there are proven interventions to reduce or eliminate vulnerability and death, yet in many locations pedestrian safety does not attract the attention it merits.

The lack of specific regulation and the power and will to punish those who violate the traffic law render to a large extent the unsafe road in many countries of Africa (Greg C. et al., 2009). Most pedestrians take shorter and easier paths, even if this is less safe. Studies in Brazil, Mexico and Uganda found that pedestrians would rather cross a dangerous road than go out of their way to take bridges/overpasses (WHO, 2004). It is a common scenario to see pedestrians crossing the Ring Road in Addis Ababa without using nearby overpasses though studies done to investigate and curb this particular problem are rare.

2.2.2 Local Perspective

With a population growth rate of approximately 3% and estimated annual increases in the motor vehicle fleet of 10-15%, the trauma of RTA is increasing in Ethiopia regardless of the low rate of motorization (UNECA, 2009). RTA in the country is critical and concentrated in areas with the highest population and traffic volumes like Addis Ababa, the capital of Ethiopia. Commercial vehicles are reported to be involved in nearly 90% of fatal crashes (Martin S. et al., 2015). A report by WHO (2004) shows that Ethiopia is one of the 10 countries that share about 62% of reported road traffic deaths in the world. Pedestrian fatalities account for 55% of total deaths in Ethiopia (WHO, 2009).

A study by Sayer and Palmner (1997), shows the pedestrians killed or injured as a percent of all fatalities is 84%. According to Dessie T. and Larson C. (1991 cited in Anteneh, 2015), over 91% of all fatalities involves pedestrians in Addis Ababa. Another report states that pedestrian fatalities in the city shares 88% of fatalities in the years from 1987/8-1993/4 (UNECA, 2009). The WHO (2009) on Global Status Report on Road Safety reveals that deaths by road user category in the country involves 55% pedestrians, 37% passengers, 6% drivers, 1% riders (motorized 2/3 wheelers), 2% cyclists and others. Even though Addis Ababa currently manifests low motorization rates by global standards, with a total vehicle fleet of 300,000 (60 % of the country's fleet) in 2015, the transport system in the city is characterized by frequent congestion and delays, high rate of RTA and air pollution (AACRTB, 2016).

Nowadays, Addis Ababa is experiencing around 700 accidents per month resulting in various levels of injury (Zewude A., 2015). As reported by AACRTB (2016), the main challenges that Addis Ababa faces are: (i) pedestrian safety concerns and high accident rates; (ii) very limited traffic management, exemplified by the severely inadequate number of traffic control signals, and the lack of a central traffic control system; (iii) ineffective planning, management and oversight of the city's public transport network (notwithstanding some important recent initiatives to develop a mass transport network); and (iv) inadequate institutional capacity underlying the above concerns and lack of coordination among different agencies shaping the city's transport system and the land use patterns.

All of the above studies and reported figures call for immediate attention to curb the problem that pedestrians are facing, particularly in the capital Addis Ababa. Regardless of the problem, pedestrians are neglected by researchers as there are rare studies which made pedestrians their issue. The author believes that this paper contributes substantial value to this area by assessing how pedestrians in Addis Ababa cross the Ring Road built for mobility, what factors affect pedestrians either to use or not to use overpasses and recommend improvement measures to enhance the utilization and performance of the facilities.

Pedestrian overpass is the only formal way of crossing the Ring Road and significant number of pedestrians take the risk of jaywalking since no attractive alternative is provided or even if some treatments like roundabouts have been introduced. A report by Sascha D. et al. (2014), had revealed that 1 out of 6 pedestrians cross the Ring Road illegally and that jaywalking is almost three times faster mode of crossing than the overpass. The paper states that crossing times are perceived much longer than the actual times, supporting the reason for the existence of jaywalkers. The Ring Road and pedestrian overpass in the city is criticized for the following reasons in general:

- Extremely large spacing of crossing facilities that may cause pedestrians to cross over barriers by putting themselves to high speed traffic;
- Poor design for the handicapped as it lacks ramps;
- Inappropriate location of pedestrian overpasses;
- No provision of pedestrian overpass or other treatments at major activity areas;
- Inconvenience of pedestrian overpasses as it may take too long to cross;
- Blockage (congestion) of the pedestrian overpasses by street vendors and beggars may force pedestrians not to use the facility than being caught in the middle of overpasses by such activities;
- Pedestrians avoid to use the overpasses while crossing the Ring Road;
- Access protecting barriers along the road have been broken and not maintained and
- Poor drainage and litter control over overpasses which may possibly discourage pedestrians to use the facility

2.3 Pedestrian Facilities

According to Jennifer B. (2016), pedestrian facilities can be broken down into components of crossing facilities, link facilities and pedestrian amenities.

Pedestrian Crossing Facility: It is important in ensuring that pedestrians are able to safely cross motorized traffic barriers or roads and they are considered to be the most critical types of facilities, as crossing is often the most dangerous part of the journey for pedestrians.

Pedestrian Link Facilities: are critical in ensuring that pedestrians can move in a comfortable, convenient and safe manner to create smooth transition of pedestrians and how passengers from motorized vehicles change from vehicles to being a pedestrian safely.

Pedestrian Amenities: are implemented to both assist pedestrians during their trip as well as part of creating a sense of place and belonging so that people can interact or relax along their journey.

2.3.1 Pedestrian Crossing Facilities

Pedestrian crossing facility is a place designated for pedestrians to cross a road and it is designed to keep pedestrians together where they can be seen by motorists and where they can cross most safely across the flow of vehicular traffic. According to LTNZ (2007), crossing facilities generally fall into three categories.

Table 2.1: Category of Pedestrian Treatments, Objectives and Possible Treatments; (Source: LTNZ, (2007)).

Category of treatment	Objective	Possible treatments
Physical aid	To simplify decisions for pedestrians & drivers by shortening the crossing distance or dividing the crossing movement into two easier crossings	Kerb extensions, Pedestrian islands, Splitter islands, Medians
Priority/time separated	To give pedestrians priority, or to allot pedestrian only periods for use of an on-road section, alternating with periods for vehicles.	Zebra crossings, School patrols, Mid-block signalized crossings, Signalized intersections
Spatially separated	To eliminate conflict by putting pedestrians and vehicles in physically different areas	▪ Overpasses ▪ Underpasses

2.4 Pedestrian Overpass

Grade separation of a pedestrian crossing from a roadway can be achieved using either an overpass or an underpass which provide the highest level of protection for pedestrians and minimizes the disruption to vehicular traffic. The distinctive characters of an overpass is that its separation of pedestrian from motorized traffic and circumvention of gap for pedestrians to cross the road unlike at-grade crossing. GSPCs are necessary to physically separate the crossing of a very heavy volume of school pedestrian traffic and a heavy vehicular flow, or where the roadway cross section is exceptionally wide, such as freeways and principal arterials (Otak, 1997).

GSPC may also be necessary to connect and maintain community linkages over major barriers such as freeways and railway lines (OTM, 2010). Thus, complete separation of vehicular and pedestrian traffic allows for a higher degree of safety compared to at-grade alternatives for high exposure locations. ERA (2002) states that when pedestrians co-exist with dense and high speed traffic, segregated pedestrian lane (footway) protected by a barrier with end treatment having protection for both pedestrians and vehicles is recommended. Generally, the benefits of overpass are two fold, namely maximizing pedestrian safety and minimizing disruption to vehicular traffic. Though most literatures do not question the safety performance of GSPCs, the following advantages and disadvantages are commonly distinguished.

Table 2.2: Advantages and Disadvantages of GSPCs (Overpasses and Underpasses)

Advantages	Disadvantages
➕ The safest type of pedestrian crossing facility ➕ Improves at grade vehicular circulation by eliminating	➕ May require greater vertical separation, long approach ramps or flights of steps, level difference resulting in longer travel times, more effort which cause problems for the elderly and persons with a mobility impairment

pedestrian caused vehicular delays and interruption - Separate physically the pedestrian movement from vehicular movement, offering pedestrians the maximum safety, thus increasing the efficiency and safety of the transportation system. - Accidents will decrease, resulting from a reduction in conflicts. - Can be readily included in new highway construction or in existing ones. - Do not cause personal security problems to the pedestrian user - No delays to vehicular traffic	- Require change in grade, with the complementary inconveniences to the different classes of pedestrians, and their acceptance of it. - May create an anticipated increase in the speed of traffic which may increase the risk for those who continue to cross at-grade - Poorly utilized (except at a school or where fencing is used) due to the level difference & longer walking distance and reduced perception of personal safety - An underpass has reduced personal security, high lighting cost and is prone to vandalism - Visually intrusive and result in privacy concerns from nearby residences, interfere adversely with adjacent properties and utilities. - Need the utilization of adequate controls to channelize and force pedestrians into using the facility. - High capital cost

Sources**:** Wayne D. and Sichun M. (2004); NZTA (2009); ADT (2011).

2.5 Pedestrian Overpass Warrants

A warrant/criteria is required to determine where the provision of pedestrian overpass would be appropriate. Warrants may differ from place to place. For instance the Alaska DOT uses three warrants: volume, gaps and geometric conditions whereas the Louisiana's DOT warrants are based entirely on volumes. Florida Handbook uses both quantitative and qualitative criteria and recommends GSPC on a highway with six or more lanes, when two activity centers are separated by a roadway; two segments of a multimodal (pedestrians and bicycles) trail need to be connected (Wayne D. and Sichun M., 2004).

The HKAC (2010) requires the justifications for providing a grade-separated crossing should take into account of anticipated pedestrian utilization, type, characteristics and layout of the road, volume and speed of the traffic, road safety and capacity considerations, desired pedestrian path, availability and location of alternative crossings, connectivity of the facility with nearby developments and walkway systems, capital and recurrent cost considerations and public opinions. Axler (1984) had identified six general types of warrants for GSPCs after extensive review of literatures: threshold, priority ranking, economic, system, policy and political. The first three are quantitative and the next three are qualitative. A description of each type of warrant from the most to least quantitative are listed as follows:

Threshold Warrants: This type of warrant is based on a set of warrants of which all or a combination of individual warrants must be satisfied. Examples of threshold warrants include vehicular volume, pedestrian volume, speed of vehicle, acceptable pedestrian gaps in traffic, preventable accidents and distance to the nearest alternative "safe" crossing.

Priority Ranking/ Point Warrants: Factors affecting the need for and potential utilization of GSPCs are either selected and/or assigned point weights or combined to form of an exposure index. Quantitative factors are assigned points according to their numerical value (i.e., pedestrian or vehicular volume) while qualitative criteria are assigned points based on professional judgments.

Economic Warrants: This warrant includes the benefit-cost, cost effectiveness, annual cost, or present worth comparisons of the construction and maintenance costs of GSPCs with alternative treatments.

System Warrants: This is a case by case evaluation of a GSPC at a specific site to determine how well it fits into the overall transportation system or master plan. The GSPC is evaluated on a generally qualitative basis concerning existing and proposed conditions.

Policy Warrants: GSPCs may be warranted in that they are built as a result of an established policy like policies to improve safety by separating pedestrian circulation patterns from the vehicular right of way.

Political Warrants: Politics can contribute to development of another type of warrant which in turn may result in building a GSPC or contribute to a GSPC being built without applying any other type of warrant.

Generally, different literatures and manuals take consideration of the different parameters to set warrants for the installation of GSPCs. These are pedestrian volumes, traffic speeds, vehicular volumes, accident history, geometric conditions, availability of alternative crossings, presence of traffic control devices and miscellaneous considerations.

Table 2.3: Common Considerations to Set Warrants for the Installation of GSPCs

Considerations	Warrants	Sources
Pedestrian volume	1. Pedestrian volume > 300 during the highest continuous 4-hour period IF: Vehicle speed > 45 MPH, The proposed sites are in urban areas, AND The proposed site is neither over nor under a freeway. ELSE, pedestrian volume > 100 during the highest continuous 4-hour period. 2. Minimum average hourly pedestrian volume 150 and minimum average hourly volume of traffic of 600 during 8 hours of an average day. 3. On freeways, the minimum of 100 pedestrians or bicyclists during any 4-hour period, 7,500 vehicles during the same 4-hour period, and an AADT of 25,000. On arterials, the minimum of 300 pedestrians or bicyclists during any 4-hour period, 10,000 vehicles during the same 4- hour period, and an AADT of 35,000. 4. The existing or anticipated pedestrian crossing volume exceeds: 100 in 4 hours IF the crossing barrier is a freeway, river, canal, railroad, or other impedance. 5. Pedestrian volume should be a total of over 300 in the 4 highest continuous hour period if vehicle speed is over 40 mph and the proposed sites are in urban areas and not over or under a freeway. Otherwise, pedestrian volume should be a total of over 100 pedestrians in the 4 highest continuous hour period.	1. Bowman et al. (1989) 2. Alaska DOT 3. Louisiana DOT 4. FPPDH(1999) 5. Axler (1984)
Traffic speeds	1. Minimum value of the 85th percentile of approaching vehicle speeds exceeds 60 km/hr, a minimum crossing width of 12 meters is exceeded,	1. Alaska DOT
Vehicular volumes	1. Vehicle volume > 10,000 during the same 4-hour period OR ADT > 35,000 IF Vehicle speed > 45 MPH AND The proposed sites are in urban areas. ELSE, vehicle volume > 7,500 in 4 hours OR ADT > 25,000 2. Minimum average hourly volume 600 during 8 hours of an average day, combined with a minimum average hourly pedestrian volume 150. 3. On freeways, the minimum of 100 pedestrians or bicyclists during any 4-hour period, 7,500 vehicles during the same 4-hour period, and an AADT of 25,000. On arterials, the minimum of 300 pedestrians or bicyclists during any 4-hour period, 10,000 vehicles during the same 4- hour period, and an AADT of 35,000. 4. Vehicle volume should be over 10,000 in the same 4 hour period used for the pedestrian volume warrant or ADT over 35,000 if both vehicle speed is over 40 mph and the proposed sites are in urban areas. If the two conditions are not met, vehicle volume should be over 7,500 in 4 hours or ADT over 25,000.	1. Bowman et al. (1989) 2. Alaska DOT 3. Louisiana DOT 4. Axler (1984)
Accident history	1. IF pedestrian volume data are not available OR instead of pedestrian volumes, consider GSPC IF, along a 300m road segment with no crossing facilities, there have been 3 or more pedestrian-vehicle crashes in 10 years, 2 or more in 5 years, OR 2 more in 3 years.	1. FPPDH(1999)
Availability of alternative crossings	1. The proposed site is > 600feet (182m) from the nearest “safe” crossing. A "safe" crossing is where a traffic control device stops vehicles to create adequate gaps for pedestrians to cross or an existing over or underpass near the proposed one. 2. There is no alternative crossing within 150 m of the candidate location for overpass.	1. Bowman et al. (1989) 2. FPPDH(1999)
Geometric conditions	1. If available sight distance is less than the stopping sight distance required by the 85th percentile approach speed, and no other crossings are available within a distance of 150m from the overpass. 2. Where a freeway intersects a pedestrian way where no vehicular structure is to be built, and no other pedestrian crossing of the freeway is available within 150m. 3. A grade-separated crossing is needed when a highway is six or more lanes.	1. Alaska DOT 2. FPPDH(1999) 3. Alaska DOT
Miscellaneous considerations	1. Consider a GSPC when - Two activity centers are separated by a roadway. - The crossing would serve a well-defined origin-destination pair, such as a school and a residential area, a parking facility and a shopping center, a neighborhood and a park, a transit stop and a campus, etc., & there is a need to prevent or offer an alternative at-grade crossings OR there are natural or man-made barriers to pedestrian crossings OR alternative crossing routes are long and circuitous OR there is community support for a GSPC. 2. If a specific need exist or be projected for a GSPC based on existing or proposed land use(s) adjoining the proposed site which generate pedestrian trips to directly access to the GSPC. 3. A GSPC may still be appropriate despite the availability of a nearby crossing if the pedestrian demand is substantially greater than the minimum required for the warrant, or if grade differences make installation of an over or underpass especially convenient.	1. FPPDH(1999) 2. Axler (1984) 3. Ottawa DOT (2009)

2.6 Dimensions of Components of Pedestrian Overpass

Minimum Vertical Clearance: Different manuals provide different figures of the minimum vertical clearance above the roadway. For instance, BCMT (2007) recommends minimum of 5.0m for any type of bridge structures over all paved highway surfaces. ERA (2002) specifies at least a 5.1m clearance above roadways; light superstructures such as timber, steel trusses and steel girders above roadways to be at least 5.3m. MnDOT (2007) sets 5.2m to be the minimum. The minimum vertical clearance is 4.4m and the desirable is 5.0m as per AASHTO (1994). The overpasses along the study route have a clearance of 5.4m.

Clear Width of Pedestrian Overpass: The width of an overpass is measured from the face of handrail to face of handrail. The recommended minimum width of an overpass for bicyclists and pedestrians is 3.6m, or the paved width of the approach path plus 0.6m, whichever is greater MnDOT (2007). ERA (2002) recommends the minimum width to be 3.0m, which can accommodate three pedestrians, or a bicycle and a pedestrian. According to Fruin (1987), the minimum-width of stair in transit applications should be 1.5m (5.0ft) to provide for convenient two-way, single-file movement. The overpasses along the study route have a width of 2.75m and usable effective width of 2.5m.

Pedestrian Overpass Railing Height: For safety considerations, ERA (2002) recommends the height of the pedestrian railings along the footways to be 1.0m by means of a top rail made of steel pipes & the height of the traffic railing to be 0.8m by means of a steel or concrete barrier. MnDOT (2007) recommends railing height to be 1.1m measured from the overpass deck. Railing height of overpasses along the study route is 1.1m.

2.7 Review of Pedestrian Overpass Effectiveness Studies

1. Measure of Effectiveness by Utilization Level

WHO (2013) states that the effectiveness of overpasses depend largely upon the likelihood that they will be used by most of the pedestrians. A study by Victor C. et al. (2015), had revealed that a longer walking distance to a pedestrian overpass or signalized crosswalk rises the probability of not using the facility. The effect is more relevant for the case of the pedestrian bridge than for the signal crossing, which may be explained by the extra effort involved in climbing stairs. A research by Kasuku O. (2001) investigated utilization levels of three pedestrian overpasses in Nairobi, Kenya, developing a formulae below as a tool for measuring utilization levels.

$U = \left(\frac{\text{p/min}}{K}\right) x100$, U - Utilization level, K - Footbridge constant or design capacity

$U_1 = \left(\frac{P_1}{K}\right) x100$, after substituting P_1 for p/min, U_1 = Footbridge use capacity, P_1- number of ped/ min.

Nonuse was measured using

$U_2 = \left(\frac{P2}{K}\right) x100$, U_2 = denotes none use of footbridge capacity

$$U_1 \& U_2 = \left(\frac{p/min}{K}\right) x100$$

Utilization levels of footbridge U is computed by

$$U = \left(\frac{P_1}{\sum(P_1 + P_2)}\right) x100 \Big/ \left(\frac{P_2}{\sum(P_1 + P_2)}\right) x100$$

Where: P_1= Ped. using bridge, P_2 = Ped. crossing within 100m radius of overpass without the overpass.

The author made an assumption that pedestrians crossing the road within a radius of 100m on either sides of the overpass were considered as traffic which were supposed to use the facility. This assumption is based on the British planning standards which state that pedestrian transport facilities should be provided to the furthest 400m a part. For instance, if footbridges were to be provided in sandwich with a level crossings, then it will be expected that a level crossing would be 200m away from a footbridge and vice versa while two footbridges and zebra crossings would be expected to be 400m away from each other.

Soltani (2013) identified, measured and analyze the scope and quality of the factors influencing the use or non-use of 20 pedestrian overpass in Shiraz, Iran, by interviewing 300 pedestrians and found that lack of lift or ramp is a crucial factor in using a bridge and low perception of personal security is a negative affective factor. Axler (1984) rated pedestrian overpasses as ‘successful’, ‘moderate’ and ‘unsuccessful’ to differentiate the degree of success based on the ratio of users to total pedestrians. Using a 90 minutes observation period of pedestrians crossing choice, Dwihasti and Tjan (2006), categorized the ratio of users to total pedestrians into certain qualitative measurements using what they called it the Criteria of Pedestrian Crossing Bridge Usage to represent the level of the overpasses effectiveness.

Table 2.4: Degree of Success of Overpass Based On the Ratio of Users to Total Pedestrians; Axler (1984)

Ratio of Users to Total Pedestrians	0.95 - 1.00	0.55 - 0.94	0.01 - 0.54
Degree of Success	Successful	Moderate	Unsuccessful

Table 2.5: Criteria of Pedestrian Crossing Bridge Usage According to Dwihasti and Tjan

Level of Usage	Very Un-Useful	Un-Useful	Quite Useful	Useful	Very Useful
Crossing Bridge Usage (%)	0 – 20	21 – 40	41 – 60	61 – 80	81 – 100

An audit report in 2010 from Hong Cong, China, had revealed that pedestrians generally preferred at-grade crossings because they were more direct and convenient, without the need to go up and down stairs or ramps. HKAC (2010) had identified the following reasons for low utilization of 22 footbridges and 17 subways:

- Low road crossing demand on one or both ends of some facilities either due to low development density or delay in the completion of developments or population intake;
- The presence of at-grade crossings (with or without signal controls) nearby, though some of the at-grade crossings were provided afterwards at the requests of the local residents or organizations for the disabled;
- The lack of facilities, such as ramps, lifts and escalators, to serve the aged and the disabled;
- Location of some facilities not along the popular or shortest routes, involve detour;
- Pedestrian concerns over security or presence of street sleepers; and
- Exceptional height of a particular footbridge (more than 10 meters above ground due to connection to upper floors of adjoining development) requiring considerable effort to use.

2. Measure of Effectiveness by Design Consistency

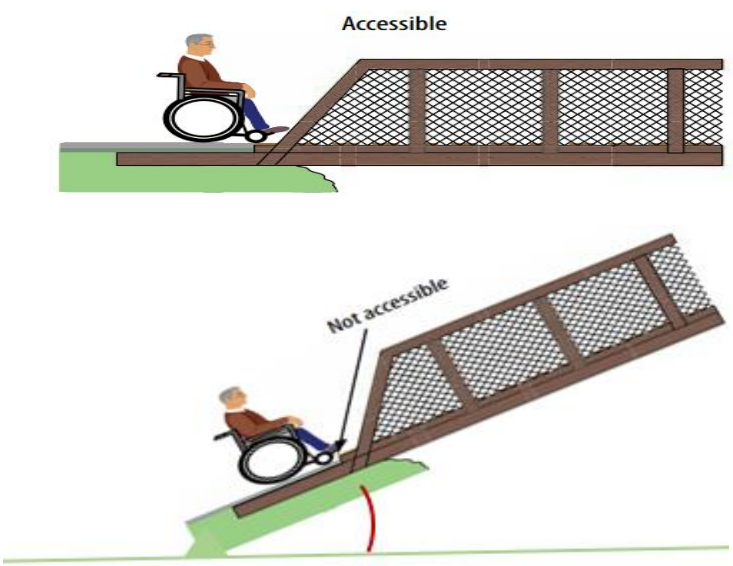
Design features of overpass affecting usage, according to Axler (1984), include physical barrier to prohibit at-grade crossing, topography of surrounding land, litter control, lighting, signing to entrance, climate, drainage, esthetic, crime and handicapped accessibility (ramp slope, ramp length, and hand rails). People with disabilities were asked to comment on accessibility issues after using three overpasses in San Francisco, California.

The eight major elements that create a barrier or hazard to users with disabilities according to Kay F. et al. (2014) were (1) Lack of adequate railings to protect pedestrians from drop-offs on overpass approaches, (2) Greater than acceptable cross slopes, (3) No level area at the terminals of the ramps on which to stop wheelchairs before entering the street, (4) Lack of level resting areas on spiral bridge ramps, (5) Railings difficult to grasp for wheelchair users, (6) Lack of sight distance to opposing pedestrian flow on spiral ramps (7) Use of maze-like barriers to slow bicyclists on bridge approaches that create a barrier to wheelchairs or who are visually impaired, (8) Lack of sound screening on the bridge to permit people with visual impairments.

Overpasses with multiple stairs are not user-friendly for the elderly or disabled pedestrians. Ramps must be designed to accommodate pedestrians in wheelchairs (WHO, 2013). A study by Templer (1980 cited in Kay F. et al., 2014) investigated the feasibility of accommodating pedestrians with physical disabilities on existing overpass and underpasses. A review of 124 crossing structures revealed that 86% presented at least one major barrier to the physically handicapped, the most common being stairs only (i.e., no ramps for wheelchair users), ramp or pathway to ramp is too long and steep, physical barriers along the access paths on the structure, sidewalk on the structure is too narrow, cross slope on the ramp that is too steep.

Accessibility relates to the degree to which a person can reach and enter a pedestrian facility. It is strongly related to universal design or design for all and making facilities accessible to as many people as possible, regardless of age, ability or personal situation. Accessibility of an overpass also includes its availability within acceptable walking distance from pedestrian attracting/generating land use zones. An underpass/overpass shall be provided within a distance of 200m from a school, hospital or factory/industrial area (IRC, 2010**)**.

Pedestrians are beneficial where if located in conjunction with well-defined pedestrian origins and destinations. Access to the deck of an overpass should be provided by both ramps and stairs, unless ramps alone would provide the most direct route to the deck, in which case the stairs may be omitted (Mott M., 2010). Stairs may supplement, but not replace a ramp; there must always be a level transition between the sidewalk and the overpass. GSPCs must meet several design requirements including being accessible to all pedestrians (WGPBP, 2010). People on wheelchairs, crutches and visually impairment require a level transition between walking area and an overpass. Pedestrians also require way finding signage for better navigation to points of interest. The type, location, length and approach gradients of such structures are the main issues related to accessibility.



A] Accessible Pedestrian Overpass: Built by taking the advantage of the natural topography. A level transition between the walking area and the overpass to provide accessibility to pedestrians with mobility impairments.

B] Inaccessible Pedestrian Overpass: A sloppy pedestrian overpass with stairs and no ramps. The edged transition provided between the walking area and the overpass is not accessible to pedestrians with mobility impairments

Figure 2.1: Typical Accessible and In-accessible Overpass for Mobility Impaired Pedestrians: Source: WGPP (2010)

3. Measure of Effectiveness by Reduction in Road Traffic Accident after Installation

Most literatures reviewed do not question the safety benefit of an overpasses as it totally separates the two modes leading to enormous advantages than any other at grade crossing. Few studies have revealed that overpasses do not serve as expected leading to bad results too. For instance, findings from studies in Brazil, Mexico and Uganda had revealed that in preference to walk long distances to use overpass, pedestrians will create their own routes, placing themselves at increased risk of injury and fatality (Solomon N. et al., 2014).

An evaluation of overpass on a major highway in Kampala, Uganda revealed that the provision of overpasses does not always have a positive result. A survey of 13,000 pedestrians in the proximity of the overpass revealed that only 35.4% of target people used the facility (Greg C. et al., 2009). After the installation, the number of pedestrians killed dropped from 8 to 2 but the number of serious injury increased from 14 to 17 (WHO, 2013). As cited in Kay F. et al, (2014), in Tokyo, Japan, analysis of reported pedestrian crashes for 6 months before and 6 months after provision of an overpasses at 31 locations was done. Crashes related to the treatment (pedestrian crossing crashes) decreased after installation; but, non-related crashes increased by 23% on the 200m sections.

Table 2.6: Comparison of Crashes Before and After Installation of Pedestrian Overpasses in Tokyo, Japan

Type of Crash	200m sections				100m sections			
	Before	After	Reduction	Effectiveness Index	Before	After	Reduction	Effectiveness Index
Related	2.16	0.32	85.1%	0.149	1.81	0.16	91.1%	0.088
Non-related	2.26	2.77	-22.9%	1.229	1.65	1.87	-13.7%	1.133
Total	4.42	3.09	29.9%	0.699	3.46	2.03	41.1%	0.567

Source: Kay F. et al. (2014) and Matt H. (2016)

This Japanese study discusses the safety effects achieved through the construction of 31 footbridges. Number of pedestrian accidents dropped by 85% on a 400m and by 91% on a 200m section with the bridge at the center (Soren U., 1998). A study of four overpasses by Demiroz et al. (2015), to investigate the factors affecting gap acceptance, crossing times and overpass use in Izmir, Turkey, showed that 46% of the pedestrians did not use the overpass in order to save time.

4. Measure of Effectiveness by Convenience (R)

It is very likely that pedestrians would not use footbridges, because it often increases the walking distance compared to level crossing. Moore (1953) studied the use of pedestrian bridges and underpasses in London and noted tentatively that roughly 80% of pedestrians would use safe path, if it takes the same time as across the road. Later Moore and Older (1965) showed that no pedestrians used the bridge if the travel time was 1.5 times or higher compared to the travel time at level crossing.

According to Moore and Older (1965), 95% of pedestrians would use an underpass and 70% would use an overpass if the travel time were equal to the crossing time at-grade. However, if it took 50% longer to cross than at grade, very few pedestrians would use the facility. As a result, provision of GSPC should be limited to locations where traffic volumes provide insufficient gaps to permit safe crossing or where the presence of roadway cuts or fill make construction of a pedestrian crossing both less expensive and more convenient for use. Measure of convenience (R), is defined as the ratio of the time or distance it took to cross the street using overpass divided by the time or distance it took to cross at street level.

$$R = \frac{\text{Time took or distance while using the overpass}}{\text{Time took or distance while crossing at grade level}} \quad \text{(2.1)}$$

The study showed that about 95% of pedestrians choose the overpass if R=1 and if the overpass route takes 50% longer (R=1.5), almost no one uses it (the facility's utilization will be almost 0%).

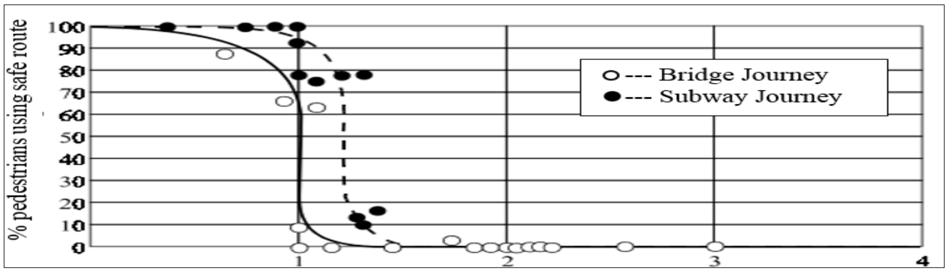


Figure 2.2: Measure of Convenience (R) versus Utilization Rate; Source: Moore and Older (1965)

5. Overpass Spacing and Acceptable Walking Distance

Long spacing have been identified as a barrier to use overpasses as the use of overpasses depend on walking distance to access these facilities; hence shall be kept within acceptable walking distances to the farthest pedestrian. As stated by WHO (2013), in addition to convenience, safety and security, the level of use of pedestrian overpass depends on walking distances compared with alternative crossing locations. Two or more crosswalk facilities shall not be placed within 200m distance of each other (Jaisung C. et al., 2013). Lots of pedestrians will not walk more than 200ft (61m) laterally in order to cross a street and pedestrians are likely to seek out other crossing opportunities when crosswalks or intersections spacing exceeds 400ft (122m) (Francis G., 2016). Crossing facilities are typically most effective when located approximately 120 to 180m apart in areas heavily used by pedestrians (Otak, 1997). A pedestrian overpass is unnecessary if a reasonable at-grade crossing is available within 180m (Ottawa DOT, 2009). Pedestrians will generally not travel further than 600ft (183m) to use an overpass if an alternate, but less safe, at-grade crossing is available (BFA, 1998).

A survey of residents travel in Tianjin, China, revealed that most pedestrian walking distance is within a range of 400-500m (Juan L. et al., 2013). The study also found that 100% of the people are willing to accept walking within 100m, 69.4% can accept 150m, 54.4% can accept 200m, and 27.5% can accept more than 200m. In public transport studies, public transport accessibility is associated with a certain number that is related to walking distance or walking time. Most of public transport studies assume that walking as an access mode occurs up to 400 to 800m of walking distance or 10 to 15 minutes of walking time (Sony S. and Piotr O., 2005). Inaccessibility or poor accessibility of public transport means that the distance or time to walk to access public transport terminal is longer than these numbers.

6. Measure of Effectiveness Using Pedestrian Level of Service Criteria (P-LOS)

P-PLOS is a measure used to estimate the effectiveness of the elements of transportation infrastructure. It is defined as an overall measure of walking conditions on a facility, path or route which is directly linked to factors that affect pedestrian mobility, comfort and safety and reflects the pedestrian's perceptions of the degree to which the facility is pedestrian friendly.

2.8 Pedestrian Level of Service Concepts

Understanding the relation between number of pedestrians demand or existing flow level a given facility can accommodate and the geometric characteristics (operating conditions) of the facility is one of the most critical requirements in traffic engineering related to walking mode. Estimation of P-LOS is the most common approach to assess quality of operations of pedestrian facilities (Singh K. and Jain P., 2011). It is a measure used by traffic engineers to estimate the effectiveness of the elements of transportation infrastructure. Pedestrian LOS is defined as an overall measure of walking conditions on a facility, path or route which is directly linked to factors that affect pedestrian mobility, comfort and safety and reflects the pedestrian's perceptions of the degree to which the facility is pedestrian friendly.

As defined by Robert M. and Brunswick V. (2002), LOS is a quantitative measure used to measure the quality of service from a user's perspective. According to Rigel et al. (2008), LOS analysis is used to determine whether the effective width of footbridge or any other pedestrian facility is enough in order for the pedestrians to have a satisfactory trip across. In general, P-LOS analysis is used to qualitatively describe operating conditions of a transport facilities based some basic indicators detecting the condition derived from pedestrian traffic flow rate, pedestrian occupant space, pedestrian density and pedestrian mean speed.

Table 2.7: Main Considerations to Determine PLOS from Different Publications

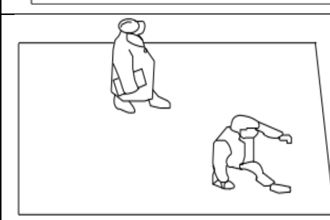
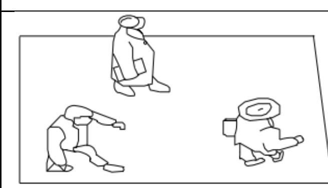
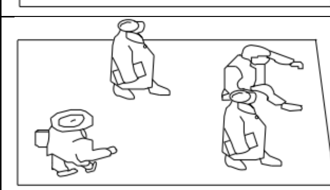
Issue	HCM2000 Method	Australian Method	Trip Quality Method	Landis Method	Conjoint Method
Geometry	Pedestrian space; v/c ratio	Path Width	Pedestrian path components	Motor path width; On-street parking	Width and separation
Flow	Pedestrian flow; Speed	Pedestrian volume; Mix of users	Not considered	Vehicle flow; Speed	Flow rate

Path	Not considered	Obstructions; Connectivity; Environment	Route; Buffer; Trees/Overhangs	Sidewalk and buffer widths	Obstructions
Vehicle Conflicts	Not considered	Potential for conflicts; Crossing opportunities	Not considered	Not considered	Bicycle events
Security	Not considered	State of security	Buffer; Transition to other spaces	Not considered	Not considered
Support facilities	Not considered	Exist or not	Not considered	Not considered	Not considered
Quality of path	Not considered	Surface quality	Path condition	Not considered	Not considered

Source: Virginia P. et al. (2006)

The 1965 edition of HCM was the first to define the concept of level of service, which has become the basis for determining the adequacy of transportation facilities from the perspectives of planning, design, and operations. Chapter-18 of the HCM2000 addresses the capacity and level of service analysis of pedestrian facilities. The HCM (2000) defines 6 ranges of LOS (from A to F), depending flow rates (V_P), space available per pedestrian (A_P), speeds and volume to capacity ratios (V/C).

Table 2.8: Pedestrian Level of Service Criteria for Walkways and Sidewalks from HCM2000

LOS	Space (A_P) (m^2/p)	Flow Rate (V_P) (p/min/m)	Speed (m/s)	V/C ratio	Remark	Pictorial representation
A	>5.6	<=16	>1.30	<=0.21	Pedestrians move in desired paths, walking speeds are freely selected & conflicts between pedestrians unlikely	
B	>3.7-5.6	>16-23	>1.27 -1.30	> 0.21-0.31	There is enough space to select walking speeds, bypass other pedestrians & to avoid crossing conflicts. Pedestrians begin to be aware of other pedestrians & respond to their presence when selecting walking path	
C	>2.2-3.7	>23-33	>1.22 -1.27	>0.31-0.44	Space is sufficient for normal walking speeds, & for bypassing other pedestrians in primarily unidirectional streams. Reverse direction or crossing movements can cause minor conflicts, & speeds & flow are lower	
D	>1.4-2.2	>33-49	>1.14 -1.22	>0.44-0.65	Freedom to select individual walking speeds and to bypass other pedestrians is restricted. Crossing or reversing flow movements face a high probability of conflict, requiring frequent changes in speed & position	

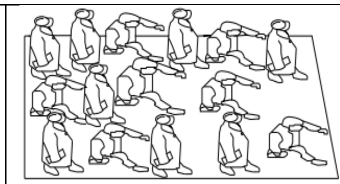
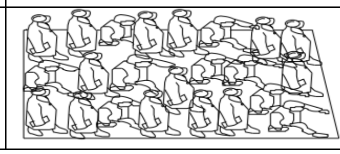
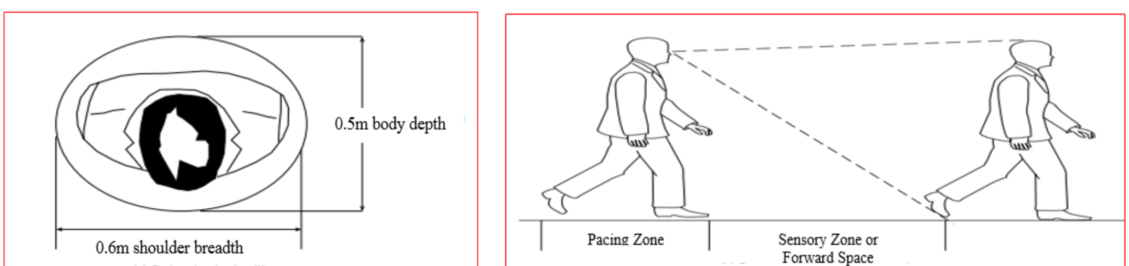
E	>0.7-1.4	>49-75	>0.76 -1.14	>0.65-1.0	Virtually all pedestrians restrict their normal walking speed frequently adjusting their gait. At the lower range, forward movement is possible only by shuffling. Space is not sufficient for passing slower pedestrians	
F	<=0.7	Variable	<= 0.76	Variable	All walking speeds are severely restricted, and forward progress is only made by shuffling. There is frequent, unavoidable contact with other pedestrians.	

Table 2.9: LOS Criteria for Stairways from HCM2000

LOS	Space (m^2/p)	Flow Rate (p/min/m)	Average Horizontal Speed (m/s)	V/C Ratio
A	>1.9	≤ 16	>0.53	≤ 0.33
B	>1.6 – 1.9	>16 – 20	>0.53	>0.33 - 0.41
C	>1.1 – 1.6	>20 – 26	>0.48 – 0.53	>0.41 - 0.53
D	>0.7 – 1.1	>26 – 36	>0.42 – 0.48	>0.53 – 0.73
E	> 0.5 – 0.7	>36 – 49	>0.40 – 0.42	>0.73 – 1.00
F	≤ 0.5	Variable	≤0.40	variable

2. 8.1 Pedestrian Space Requirements for Walking and Standing

The primary performance measure of pedestrian facilities is space, the inverse of density. A body depth and shoulder breadth for minimum space standards is used by pedestrian facility designers. A simplified body ellipse of 0.5m(1.5ft) x 0.6m(2.0ft), with total area of 0.3m^2(3ft^2), is used as the basic space for a single pedestrian (HCM2000). This represents the practical minimum for standing pedestrians. In evaluating a pedestrian facility, an area of 0.75m^2 (8ft^2) is used as the buffer zone for each pedestrian. A walking pedestrian requires a certain amount of forward space. This forward space is a critical dimension since it determines the speed of the trip and the number of pedestrians that are able to pass a point in a given time period. The forward space is categorized into a pacing zone and a sensory zone.



(a) Pedestrian body ellipse (b) Pedestrian walking space requirement

Figure 2.3: Pedestrian Body Ellipse and Pedestrian Walking Space Requirement: Source: - HCM2000

Table 2.10: Comparison of Human Ellipse, Source: Natasha S. et al. (2016)

Source/ Author	Country	Body Dimension	Body Dimension (Converted Into SI Units)
Fruin (1987)	USA	13in x 23in	0.33m x 0.58m
Still (2000)	UK	0.5m x 0.3m	0.5m x 0.30m
HCM (2000 & 2010)	USA	1.5ft x 2.0ft	0.50m x 0.60m
TCRP Report 165	USA	20in x 24in	0.50m x 0.60m

2.8.2 Capacity of Pedestrian Facilities

In engineering terms, pedestrian congestion occurs when a facility is operating over capacity. Capacity refers to the maximum possible ability to accommodate a flow (Pushkarev and Zupan, 1975 cited in Angela L, 2006). To analyze the capacity, the peak 15 minutes of the peak hour is used. The HCM (2000) takes capacity as 75ped/min/m and 49ped/min/m for walkways and stairs respectively. The space available per pedestrian when the facility is at capacity is $0.75m^2$, being the probability of conflict between pedestrians very high. A capacity of 75p/min/m is a reasonable value for a pedestrian facility if local data is not available.

Millazo et.al (1999) pointed out that capacity ranges from 72p/min/m for an American facility to 90p/min/m for Asian facilities. The Asian capacity values may be more for American facilities, given the closer physical contact accepted by Asians (Natasha S. et al., 2016). This is one major drawback of adopting the HCM (2000) for countries with different cultures different from USA's where physical contact is tolerated and different body dimensions exist.

2.8.2.1 Procedures to Compute Pedestrian Level of Service (P-LOS)

Pedestrian facilities need to be designed to provide adequate level of service (LOS) during the ***period of greatest activity***. LOS analysis can be used to determine whether the effective width of any facility is enough in order for pedestrians to have a satisfactory trip across. The HCM (2000) defines 6 ranges of LOS (from A to F) depending on space per pedestrian, flow rates, speed and V/C ratio. Urban areas usually adopt standards varying between "C" and "E" depending on the area's size and characteristics to evaluate pedestrian facilities (Sambhu M., 2013).

A *LOS of C* or better is considered acceptable for pedestrian paths and for designated accessible routes; a *LOS of B* or better is desirable to accommodate persons with disabilities who require more space (WMATA, 2005). Pedestrians normally slow down on stairways, so stairways must be wider than sidewalks to achieve the same LOS. WMATA (2005) suggests stairways to be designed to operate at ***LOS C*** (or better) during the peak 15-minute period. Following are the steps/procedures to determine LOS.

Step 1: Determination of Effective Walkway Width (W_E): Effective walkway width is the portion of a walkway that can be used effectively by pedestrians. The effective walkway width at a given point along pedestrian facilities is computed as follows:

$$\mathbf{W_E = W_T - W_O} \qquad \textbf{(2.2)}$$

Where: W_E = effective width, W_T = total walkway width at a given point along walkway, and W_O = sum of fixed object effective widths and linear feature shy distances at a given point along the facility.

Step 2: Calculation of Pedestrian Flow Rate (V_P): Pedestrian flow rate is the number of pedestrians passing a point per unit of time, expressed as pedestrians per minute per meter. Point refers to a line of sight across the width of a walkway perpendicular to the pedestrian path. Determination of the peak 15-minutes count and the effective walkway width is required to compute pedestrian unit flow rate, V_P. Pedestrian flow per unit of width (V_P) is the peak flow of pedestrians (V_{15}) per unit of effective walkway width (W_E), expressed as pedestrians per minute per meter (p/min/m).

$$V_P = \left(\frac{V_{15}}{15 x W_E} \right) \text{ - } \textbf{(2.3)}$$

Step 3: Calculation of Average Pedestrian Space (A_P): Pedestrian space is the average area provided for each pedestrian expressed in square meters per pedestrian. It is the most important parameter for designing and evaluating a pedestrian facility at it is the area required by a pedestrian to stand comfortably or make a comfortable movement which is referred as Body Ellipse and depends on shoulder width and body depth (Natasha S. et al., 2016**)**. In ***evaluating*** a facility, an area of $0.75m^2$ is used as the buffer zone for each pedestrian. A walking pedestrian requires forward space which is a critical dimension, since it determines speed and the number of pedestrians able to pass a point in a given time period.

Fruin (1987) classified the space zone for locomotion as Pacing Zone (area required to walk) and Sensory Zone (area in front of the pedestrian required for a smooth unobstructed flow). Individual pacing distance combined with perception and reaction times give the sensory zone. Fruin (1987 cited in Natasha Singh et al., 2016) suggested a body buffer zone of $0.75m^2$ for walking. According to Fruin (1987), longitudinal spacing for walking including for pacing and avoiding conflicts, would be 2.5m to 3m. The personal space required for comfortable movement on stairs is less than walking because of the limitations imposed by the treads and concerns for safety. Pedestrian space cannot be directly observed in the field. The pedestrian unit flow rate (V_P) can be related to pedestrian space (A_P) and speed (S_P) using equation below.

$$A_P = \left(\frac{S_P}{V_P} \right) \text{ - } \textbf{(2.4)}$$

Step 4: Calculation of Volume to Capacity Ratio (V/C): HCM2000 computes volume to capacity (v/c) ratio assuming 75ped/min/m (23ped/min/ft) and 49ped/min/m (15ped/min/ft) for capacity analysis of walkways and stairs respectively in case of no local data is available.

Step 5: Determination of Pedestrian Level of Service (P-LOS): PLOS categories are labelled A to F on the basis of flow rate, average pedestrian space, average speed and volume to capacity ratio based on HCM2000 pedestrian LOS criteria tables for the slab/deck of the overpass and stairways independently.

The research methodology design and analysis procedures in the next two chapters are formulated based on basic concepts in the literature review discussed above.

CHAPTER - 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides details of the study area, types of data required for the study, sampling techniques and the methods that were used for collecting the various data along with the tools employed. The chapter also discusses and describes techniques used to analyze the data that yields answers to the research questions and realize the objectives of the research.

3.2 Study Design

The steps followed to come across the objectives of the study are identifying and defining the problem from field observation, review of relevant literatures and formulation of appropriate methodology for data collection and analysis stages. Relevant information and key concepts were gathered from literatures which was used to set different criteria to evaluate the performance and effectiveness of an overpass. Next to review, developing a research question and establishing an objective was followed by developing an applicable methods to provide answers for the research questions. Statistical sampling technique was used to gather the necessary data suitable for the analysis plan at different levels. From the results found in the analysis stage, conclusions and recommendations were drawn.

3.3 Study Area

The pedestrian overpasses to be assessed are provided along the Megenagna-Bole-Saris-Kality-Hana Mariam road which is part of the Addis Ababa Ring Road. The study was conducted on seven pedestrian overpasses along the study route of length about 14km. The Ring Road has a width of 37m which makes it the second widest road in the city next to Churchill road which is 48m wide (Sascha D. et al., 2014). It was initially planned as a frame around the city, providing a more efficient link for vehicles; however, as urbanization spread faster than expected, the road now cuts through the outer skirts of the city like a knife, dividing neighborhoods from each other (Sascha D. et al., 2014). Figure 3.1 and Table 3 below shows the locations of the seven overpasses, reference area names or land marks and short labels of the overpasses to be used throughout this paper.

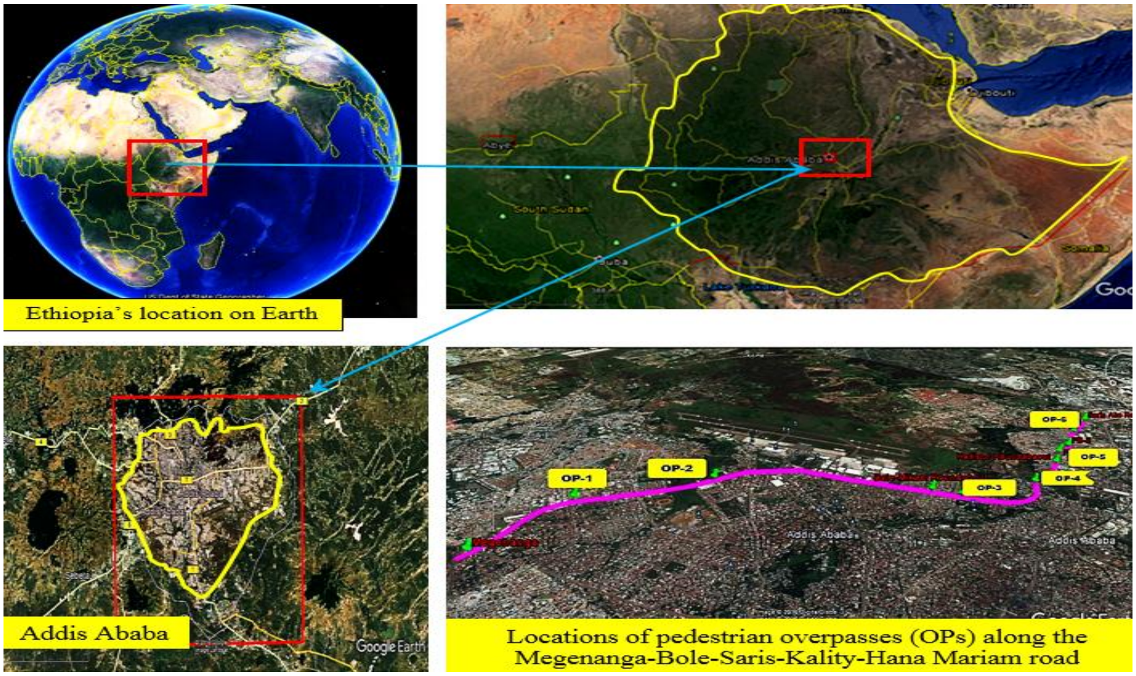


Figure 3.1:- Geographic Location of the Study Area from Google Earth

Table 3.1: Labels and Locations of Pedestrian Overpass With Reference to Local Names

Overpass Designation (Label)	Pedestrian overpass Location (Local Reference landmark)
OP-1	Nyala Motors/Anbessa Garage
OP-2	Hayat Hospital
OP-3	Bole Mikael Bridge
OP-4	St. Yoseph Church
OP-5	Saris Addisu Sefer
OP-6	Ersha Sebil
OP-7	Hana Mariam

NB: "OP" is Short Label for 'Overpass'

3.3.1 The Modal Share of Walking in Addis Ababa

Addis Ababa is the capital city of Ethiopia with an area of 527 km^2 and a total population of more than 3.5 million, comprising approximately 60 % of the total urban population of Ethiopia (Peng M. et al., 2008). A report by Dejene M. (2013) states that the modal share of walking in Addis Ababa is between 60% and 70% whereas the share of transportation by vehicle is between 30% and 40%. Another report by Trans-Africa (2008) broadly splits the share as: 10% private car, 25% public transport and 60% walking. The higher involvement of pedestrians in RTA in the city may have been simply due to increased exposure i.e more people making walking trips than is the case for cities in developed countries. It is therefore not surprising that they constitute the road user group appearing most frequently amongst those injured and killed in road accidents.

3.3.2 Profile of the Addis Ababa Ring Road

The Ring Road had brought both desirable and undesirable changes to the city. It has allowed heavy vehicles entering the city from the main radial routes to bypass portions of the city and it became possible to avoid the city center, reduced traffic congestion in the area and linked neighborhoods with market places, schools, churches and clinics, the diminishing traffic congestion in turn had reduced the risk of traffic accidents (Sascha D. et al., 2014).

The Ring Road marks the first attempt to introduce an urban freeway which led the city's street network to extend rapidly (+21% in total between 2005 and 2010) (Sascha D. et al., 2014). The road was initially planned as a frame around the city, providing a more efficient link for vehicles; however, as urbanization spread faster than expected, the road now cuts through the outer skirts of the city like a knife, dividing neighborhoods from each other Sascha D. et al. (2014). According to Yetnayet (2012), Addis Ababa has a radial form of road network which is shaped by five major roads radiating out from the center in to the outskirts but the road has added an orbital shape around the periphery of the center.

3.4 Data Types, Sources and Collection Procedures

The data types used in this study are primary data which include pedestrian count both users and non-users of overpasses every 15-minutes for three weekdays at each site for 8 hours, field observation and measurements (dimensions like width and length of overpasses, spacing of pedestrian treatments along the road) and responses from pedestrians gathered through questionnaire. Questionnaire was distributed both for users and non-users of overpass while crossing the road. To measure the convenience of the overpass facilities, the sample time took by pedestrians to cross the Ring Road by means of the two alternatives (overpass vs at-grade) was also recorded in the field. The data types and collection procedures used in this study are briefed below.

3.4.1 Pedestrian Counting

Counting the number of pedestrians crossing the Ring Road either by using the overpass or without it within 100m from the overpass in both sides was one of the tasks during data collection process. Manual counting was implemented within 200m range of distance. The counting was held for 8-hours on three randomly selected weekdays at each site from 8:00AM-12:00PM in the morning and 2:00PM-6:00PM in the afternoon where the highest pedestrian flow is expected to occur. The counting was also conducted at four locations where there is no alternative crossing facility and high volume of jaywalk crossing exists.

Precaution had been made to select the counting days not to coincide with religious/ public holydays, street demonstration as well as sport festivity days which might distort the results.

Table 3.2: Selected Pedestrian Counting Days

Overpasses	Selected Counting Days		Overpasses	Selected Counting Days	
Nyala Motors (OP-1)	Day-1	Tuesday (October 10/2017)	Saris Addisu S. (OP-5)	Day-1	Monday (October 16/2017)
	Day-2	Monday (April 23/2018)		Day-2	Wednesday (April 25/2018)
	Day-3	Thursday (April 26/2018)		Day-3	Monday (April 30/2018)
Hayat Hospital (OP-2)	Day-1	Wednesday (Oct. 11/2017)	Ersha Sebil (OP-6)	Day-1	Tuesday (Oct. 17/2017)
	Day-2	Tuesday (April 24/2018)		Day-2	Wednesday (April 25/2018)
	Day-3	Thursday (April 26/2018)		Day-3	Monday (April 30/2018)
Bole Mikael (OP-3)	Day-1	Thursday(Oct. 12/2017)	Hana Mariam (OP-7)	Day-1	Thursday (Oct. 19/2017)
	Day-2	Tuesday (April 24/2018)		Day-2	Wednesday (April 25/2018)
	Day-3	Thursday (April 26/2018)		Day-3	Friday (April 27/2018)
St. Yoseph Church (OP-4)	Day-1	Friday (Oct. 13/2017)			
	Day-2	Tuesday (April 24/2018)			
	Day-3	Monday (April 30/2018)			

3.4.2 Questionnaire

Questionnaire is the simplest and time saving method to collect data effectively from a huge number of respondents. It was used to identify factors affecting pedestrians for not using overpasses, their perception towards the facilities spacing, location appropriateness, design, capacity and accessibility as well as preferred remedial measure to maximize utilization rate with acceptable LOS and performance. Questionnaire paper was distributed for pedestrians of both users and non-users of the overpass and collected soon on the same day. It was distributed to a randomly selected pedestrians of different age, gender, educational background etc. A combination of a closed-ended and open questionnaire types had been used by which respondents can simply select from closed question and given opinion on some of the open ended question. The respondents were asked to rate the parameters to be assessed on different scale of measures.

Table 3.3: Objective (Parameters to be Assessed) Versus Question Numbers

No	Objectives	Questionnaire Order Numbers
1	Personal Information Of Respondents	1, 2, 3, 4 and 6
2	Perception and Behaviour of Respondents	5, 8, 11, 15 and 20
3	Location Appropriateness Overpass	7, 17 and 19
4	Capacity of Pedestrian Overpass	9, 10 and 21
5	Spacing of Pedestrian Facilities	12, 13, 14 and 22
6	Remedial Measures Suggested By Pedestrians	16 and 23
7	Accessibility and Design Issues	17, 18 and 24

3.4.3 Time to Cross and Distance Traversed

For the purpose of measuring the convenience of the overpasses, comparison of time took by grade crossing versus the overpass was made. Sample time records of both means of crossings are the inputs to compute the measure of convenience (R) of the pedestrian overpass facilities along the study route.

3.4.4 Dimension and Distance Measurements

The physical dimensions of the overpasses such as width and length were measured in the field using measuring tape to be used as inputs for the computation of average pedestrian area (space), density and flow rate. Measuring tape was used took to locate 200m ranges of distances properly and measure distance between important locations and spacing between pedestrian facilities.

Figure 3.2: Ranges of Distances Considered During Pedestrian Counting (Picture from Google Earth)

3.5 Data Collection, Presentation and Analysis Methods

For data collection, an inclusive data collecting formats were used as the manual method of pedestrian counting was implemented (see the Appendix). Responses from pedestrians was gathered through objective questionnaire in the field. Sample time took by pedestrians to cross the road was recorded using a stop watch and noted on a data collection sheet prepared for both users and non-users. An ordinary distance measuring tape was used to locate ranges of distances in the field, to measure dimensions of the overpass, spacing between facilities and important locations of interest. For the purpose of data presentation and analysis, a personal computer and a Microsoft Office tool (Microsoft Excel) was used.

3.6 Sampling Method

I. Sample Size for Questionnaire Survey Respondents

In order to determine the sample size for the questionnaire survey respondents, the population (pedestrians crossing the study route i.e the Ring Road with or without overpasses) is very large or unknown exactly. Hence, for a population that is too large or not known precisely, the sample size (n) is determined using Equation below.

$$n = \frac{Z^2}{e^2} * p * (1-p) \qquad \textbf{(3.1)}$$

Where: n = sample size, Z = Confidence interval (CI), e = Margin of error and p = Standard deviation (degree of variability)

Using the commonly used value of 95% CI (Z-score = 1.96) with margin of error e = 5% and a standard deviation of p = 0.5 would yield a sample size of 385 which is too small. Hence for the purpose of this study a confidence level CI = 90% (Z-Score = 1.645), margin of error e = 2.5% and a standard deviation of p = 0.5 was preferred to obtain large sample size which the researcher believes is good to comprehensively evaluate the pedestrian overpasses in detail by incorporating large respondents in the survey.

$$n = \frac{Z^2}{e^2} * p * (1-p),\ n = \frac{1.645^2}{0.025^2} * 0.5 * (1-0.5) = 1082.4 \approx 1083$$

Hence total of 1083 sample pedestrians were involved in the survey out of which 1063 responded fully and 20 pedestrians failed to complete the questionnaire (98% response rate). The pedestrians were of two type i.e overpass users (840) and non-users (223). The questionnaire was designed in two ways incorporating general questions regarding the Ring Road as a whole and independently evaluate each overpass along the study route.

II. Sample Size for Crossing Time observations

Volume of pedestrians crossing the study route with or without overpasses is very large or unknown exactly. Hence, for a population that is too large or population not known precisely, the sample observation (n) of crossing time is determined using Equation 3.1 above. With a 90% CI (Z-Score = 1.645), margin of error e = 3.5% and a standard deviation of p = 0.5 yields a sample size of 552.3.

$$n = \frac{Z^2}{e^2} * p * (1-p),\ n = \frac{1.645^2}{0.035^2} * 0.5 * (1-0.5) = 552.3$$, sample size of 560 for convenience.

The 560 sample size was divided equally for each of the seven overpass based on quota sampling technique which is 80 for a single overpass. Out of the 80 sample size, 40 sample was allotted for non-users and 40 for user pedestrians. The non-users (40 samples) were observed within 100m on the left and

100m on the right side of the facilities. The 100m range was divided into four rages of distance (25m) which is 50m when both sides are considered in order to have an evenly distributed sample observation and avoid data collection at a fixed point within the specified range of distance. Hence the 40 sample size observation (time pedestrians took to cross the Ring Road without overpass facilities) was divided evenly so that 10 sample observations will be made for each 50m range of distance from the facility.

3.8 Data Analysis

The following table summarizes the four research objectives, specific cases for analysis, types of data required and method of analysis.

Table 3.4: Analytical Framework

Research Specific Objectives	Specific case for analysis (Specific Questions)	Types of Data	Methods of Analysis
1. To evaluate the rate of utilization of pedestrian overpass facilities along the study route (Megenagna-Bole-Saris-Kality-Hana Mariam)	(A) What is utilization rate of overpasses taking in to account of the following two cases: Case - I: Users and non-user pedestrians within a range of 100m distance in both sides from the facility and Case-II: Users and non-user pedestrians up to half distance to the next pedestrian facility in both sides (B) What factors affect pedestrians to use/not use overpasses along the study route?	- Number of pedestrian crossing the Ring Road with or without using overpasses for 8 hours (at different range of distance) - Questionnaire survey	- Formula - Percentages - Descriptive
2. To evaluate the performance of the pedestrian overpasses along the study route.	(A) What are main indicators of effectiveness (performance) of pedestrian overpasses? (B) What is the Level of Service of pedestrian overpasses along the study route for the following cases? Case-I: Considering overpass users only Case-II: Considering overpass users plus non-users within 100m in both sides and Case-III: Considering overpass users plus non-users within up to half distance to the next pedestrian facility in both sides from the facility. (C) Do the overpasses fulfill a PLOS-'C' during peak hours? If not, what width will be sufficient to meet LOS-C? (D) How is the convenience measure (R) of the pedestrian overpasses characterized?	- Number of pedestrian crossing the Ring Road every 15minutes with or without overpasses for 8-hours (within different ranges of distance) - Recorded time took by pedestrians to cross the Ring Road with or without overpasses	- Formula - Compare and Categorize as per HCM2000 Criteria Tables - Descriptive

3.To evaluate the spacing, location appropriateness, capacity, design and accessibility of overpasses along the study route.	(A) Is the current locations of the overpasses appropriate for the purpose of trip pedestrians are making? (B) Is the current locations of the overpasses appropriate and within acceptable walking distance for popular origins and destinations such as schools, markets, religious centers, transport terminals etc? (C) Is the design, accessibility, spacing and capacity of pedestrian overpasses in compliance with desirable requirements for pedestrians?	- Questionnaire survey data - Literatures regarding design, spacing, location and accessibility of pedestrian overpasses - Measurement data from field (widths, lengths, spacing)	- Comparison with standards, best and common practices, specifications - Percentages - Descriptive
4.To recommend methods for improving the utilization and performance of overpasses and identify locations where high volume of illegal crossing exist along the study route which calls for attention.	(A) What measures can be considered to improve the utilization rate and performance of pedestrian overpasses along the study route to enhance the safety, accessibility and comfort as suggested by most pedestrians? (B) Which locations, along the study route, entertain high volume of illegal crossing activity due to absence of alternative treatments and call for attention?	- Questionnaire - Non-user counts	- Checking existing conditions against some warrants - Percentages - Descriptive

3.8.1 Rate of Utilization of Pedestrian Overpasses (U)

The utilization rate of pedestrian overpasses along the study route was computed by taking in to account of pedestrians crossing the Ring Road in the following two cases:

Case - I: Users and non-user pedestrians within a range of 200m distance (100m in both sides from the facility)

Case-II: Users and non-user pedestrians up to half distance to the next pedestrian facility in both sides ($X_L/2$ and $X_R/2$) (See Figure 4.1)

Case-I is used to determine to what extent are the nearest pedestrians using the facility as they are supposed to use it and case-II is used to determine how well is the facility being used by the farthest pedestrian from it. Utilization rate (U_R) of the pedestrian overpasses was computed by dividing the number of pedestrian crossing the Ring Road using the overpass (A) by the total non-user pedestrians within 200m range of distance (B) plus those who used the overpass (A) for analysis Case-I.

$$U_R = \frac{A}{(A+B)} * 100 \quad \text{------------------------------------} \quad \textbf{(3.2)}$$

Non-user pedestrians within half distance of the next pedestrian crossing treatment in both sides were also considered to compute the utilization rate of overpasses (Case-II). For this purpose, nun-user count within the nearest 100m were assumed to remain the same throughout the rest of the distance (up to half distance of the next pedestrian crossings) in both sides. So, distance from the facilities was used as a factor to convert the number of non-users within the first 100m to represent the rest (where counting had not been carried out). Hence the utilization rate (U) in Case-II will be the ratio of number of pedestrians crossing the Ring Road using the overpass (A) and the total number of non-user pedestrians within half distance of the next pedestrian crossings in both sides (D) plus those who used the overpass (A).

$$U = \frac{A}{(A+D)} * 100 \qquad \textbf{(3.3)}$$

Number of pedestrians (D) crossing the road without an overpass within up to half distance of the next pedestrian crossing was computed by multiplying non-users (counted from field) within the first 100m by a distance factors as given in Table 4.4. Assigning L_i and R_i to be volume of non-user pedestrians within the first 100m on the left and right side of the pedestrian overpass respectively, computation of D is as illustrated using Table 4.4.

The 1st 15-minutes count within the first 100m (from 8:00-8:15AM) on the left and right side are represented as L_1 and R_1, the 2nd count (from 8:15-8:30AM) as L_2 and R_2 and the last (32nd) count (from 5:45-6:00PM) as L_{32} and R_{32}. If 100m represents L_i volume of pedestrian for a single 15-minute count on the left side, then 750m would represent $7.5L_i$ non-users within up to half distance to the facility on the left side of Nyala Motors overpass (OP-1), i.e *Megenanga* which is 1500m away. Hence a factor of 7.50 is used to represent non-user pedestrian volume up to 750m towards Megenagna. On the right side of Nyala Motors overpass (OP-1) is another crossing facility at 700m, i.e *Imperial Junction*. Half distance between the two is 350m. Hence a factor of 3.50 is used to represent non-users volume up to 350m distance towards *Imperial Junction*. Therefore, non-users up to half distance of the two facilities in both sides from Nyala Motors overpass will be $D = \Sigma(7.50L_i+3.50R_i)$. Therefore, total non-users (D) up to half distance from a particular pedestrian overpass, in both sides, is computed using equations in column 4 of Table 4.4. Equation 3.4 below is used to compute D of Nyala Motors (OP-1).

$$D = \sum_{i=1}^{32} (7.5Li+3.5Ri) \qquad (\mathbf{3.4})$$

Other than analysis formulas used above, a questionnaire was distributed to pedestrian of two types (i.e users and non-users) to assess their perception of crossing the Ring Road without overpasses, to identify factors that affect pedestrians either to use or not to use the facilities. Pedestrians were also asked to recommend improvement measures to enhance the utilization and performance of the facilities.

3.8.2 Performance of pedestrian Overpasses

This study mainly seeks to measure the performance of the overpasses along the study route primarily using the most common method i.e Level of Service criteria from HCM2000 which is internationally accepted and adopted manual to evaluate performance of transport facilities. In addition to P-LOS analysis, the measure of convenience (R) of the overpass facilities was also computed.

3.8.2.1 Pedestrian Level of Service (P-LOS)

PLOS categories are labelled A to F on the basis of average pedestrian space (A_P), flow rate (V_P) and volume to capacity ratios (V/C). The PLOS ranges defined in this study are adopted from HCM (2000). The level of service of the overpass facilities along the study route was computed by taking in to account of the volume of pedestrians crossing the Ring Road in the following three cases;

Case-I: Pedestrian count data crossing the Ring Road using the overpass only;

Case-II: Pedestrian count data crossing the Ring Road using the overpass and without the overpass within 200m range of distance (i.e 100m on the left and right side of the facility)

Case-III: Pedestrian count data crossing the Ring Road using the overpass and non-users up to half distance to the next facility (i.e $X_L/2$ in the left & $X_R/2$ in the right side of the facility in Fig. 4.1)

Case-I expresses to what degree the facilities are serving USER pedestrians. Case-II enquires to what would happen to the LOS of the facilities if the nearest NON-USER pedestrians are diverted to the facility from both sides (within 100m). The third case enquires what would happen to the LOS of the facilities if the farthest NON-USER pedestrians are diverted to the facility from both sides. Results from case-III helps to show whether the facilities are capable of accommodating all pedestrians that are supposed to be served. The last two cases of analysis (Case-II and III) were used to evaluate LOS of the facilities by assuming the utilization rate is 100%.

Pedestrian volume data beyond the first 100m from the facility was assumed to follow the same pattern with that of first 100m actual count and added to the previous counts to see the variation in LOS and compute how well the facilities can accommodate pedestrians without exceeding a pedestrian level of service (PLOS-C). Following are the steps followed to determine the level of service (P-LOS) of pedestrian overpass facilities.

STEP 1: Determination of Effective Walkway Width (W_E)

Effective walkway width is the portion of a walkway that can be used effectively by pedestrians. The effective walkway width at a given point along pedestrian facilities is computed as follows:

$$W_E = W_T - W_O \qquad \textbf{(3.5)}$$

Where: W_E = effective walkway width, W_T = total walkway width at a given point along walkway, and W_O = sum of fixed object effective widths and linear feature shy distances at a given point along the facility.

STEP 2: Calculation of Pedestrian Flow Rate (V_P)

Pedestrian flow rate is the number of pedestrians passing a point per unit of time, expressed as pedestrians per 15 minutes or pedestrians per minute. Point refers to a line of sight across the width of a walkway perpendicular to the pedestrian path. The peak 15-minutes count and the effective walkway width is required to compute pedestrian unit flow rate, V_P. The volume of pedestrians crossing for every 15 minute of the peak hour is counted manually. The peak 15 min. volume is observed. Dividing it by the effective width (W_E) of the facility gives the flow per meter. This flow value per minutes gives the flow rate in pedestrians/min/m.

$$V_P = \left(\frac{V_{15}}{15 x W_E} \right) \text{-------------------------------- } \mathbf{(3.6)}$$

STEP 3: Calculation of Average Pedestrian Space (A_P)

Pedestrian space, which is the inverse of density, is a more practical unit for analyzing pedestrian facilities, is defined as the average area for each pedestrian on a pedestrian facility, expressed in terms of square meter per pedestrian (m^2/p). The most important parameter for designing and evaluating a pedestrian facility is the area required by a pedestrian to stand comfortably or make a comfortable movement which is referred as Body Ellipse (Human Ellipse) and depends on shoulder width and body depth of a human being (and also on the kind of activity i.e. Standing or Walking). Pedestrian space cannot be directly observed in the field; but the pedestrian unit flow rate can be related to pedestrian space and speed. PLOS for the stairways was computed by considering the ascending and descending speed of pedestrians separately.

$$A_P = \left(\frac{S_P}{V_P} \right) \text{------------------------------------ } \mathbf{(3.7)}$$

A_P = pedestrian space (m^2/p), S_P = ped. speed (m/minutes), and V_P = ped. flow per unit width (p/min/m).

Step 4: Calculation of Volume to Capacity ratio (V/C)

For determination of PLOS, volume to capacity (V/C) ratio is one of the most important factor. The demand (peak flow rate values) and capacities of 75ped/min/m and 49ped/min/m respectively were used to compute the V/C ratios of the overpass facilities along the study route.

Step 5: Determination of Pedestrian Level of Service (P-LOS)

PLOS categories are labelled A to F on the basis of average pedestrian space (A_P), flow rate (V_P) and volume to capacity ratios (V/C) as adopted from HCM (2000). Another case of analysis inquires whether the overpasses fulfill a level of service ‘C’ during peak hours or not. Effective width (W_E) required to keep a LOS-C (if PLOS found to be less than C from analysis) was to be computed by considering the pedestrians within the different ranges of distances in both sides.

3.8.2.2 Measure of Convenience (R)

Measure of convenience (R) is defined as the ratio of the time it took to cross the street on an overpass divided by the time it took to cross at street level. It can be also computed by considering the distance to be crossed while using the two alternatives. R of each overpass was computed using the following equation.

$$R = \frac{\text{Time took or distance while using the overpass}}{\text{Time took or distance while crossing at grade level}} \quad \text{- - - - - - - - - - - - - - - - -} \quad \textbf{(3.8)}$$

Pedestrians were also asked to rate the time they perceive will save if they crossed without the overpasses.

3.8.2.3 Location Appropriateness, Spacing, Accessibility, Capacity and Design of Overpasses

Questionnaire was designed and forwarded for pedestrians to rate the current location of the facilities, spacing between two consecutive overpasses or an overpass and the next crossing treatment, design issues to meet diverse needs, accessibility, capacity and recommend improvement measures to increase the utilization and performance of the facilities. Different literatures were extensively reviewed to see requirements of a standard and inclusive design of pedestrian overpass to accommodate and satisfy the needs of the disabled, elderly and child pedestrians in additional to field observations and questionnaire survey.

Spacing (distance between two consecutive overpasses or an overpass and the next pedestrian facility) is said to be acceptable if most pedestrians accept and are willing to walk to the next facility; i.e if the distance is negotiable by most pedestrians at the furthest point to either of two alternatives. Spacing will be compared against the acceptable walking distance set to be 400m for the purpose of this study. This will be used as specific case of analysis to see whether the spacing (distance between pedestrian overpass) is too long that puts extra effort on pedestrians or not. Pedestrians were asked to suggest places, along the study route, where there is no alternative crossing facility and as a result high volume of illegal crossing activities exist. From the response and field observation feedbacks, the same counting technique was applied to assess which warrants are met for provision of crossing facilities.

CHAPTER - 4

ANALYSIS, RESULTS AND DISCUSSIONS

This chapter provides findings in relation to the objectives set out at the beginning, discussions and interpretation of the results. The chapter briefs analysis results of utilization rates of pedestrian overpasses, factors for poor utilization, performance of overpasses in terms of LOS and R and suggested remedial measures to improve the hindering factors related with overpass utilization.

4.1 Analysis of Utilization Rate of Pedestrian Overpasses

A total of 103,342 pedestrians were observed while crossing the Ring Road out of which 92,824 had used overpasses and 10,518 were illegal which account to 89.8% and 10.2% respectively. Male pedestrians are highly represented in illegal crossing activity as compared to female pedestrians. Out of the 10,518 illegal crossings, 91.9% (9,669) was commuted by male pedestrians and 8.1% (849) by female pedestrians. This complies with the fact that male pedestrians have a risk taking behaviour as compared to female pedestrians.

Table 4.1: Pedestrian Volume Data during the 8-Hour Observation Period at Each Counting Days

Overpasses	Days	Overpass User Pedestrians by Gender					Non-User Pedestrians by Gender					Overall
		M	F	Total	M (%)	F (%)	M	F	Total	M %)	F (%)	
Nyala Motors (OP-1)	D-1	2,974	1,874	4,848	61%	39%	758	34	792	96%	4%	5,640
	D-2	3,034	1,955	4,989	61%	39%	760	49	809	94%	6%	5,798
	D-3	2,667	1,527	4,194	64%	36%	791	70	861	92%	8%	5,055
Hayat Hospital (OP-2)	D-1	1,452	782	2,234	65%	35%	147	4	151	97%	3%	2,385
	D-2	1,588	820	2,408	66%	34%	118	31	149	79%	21%	2,557
	D-3	1,317	738	2,055	64%	36%	146	11	157	93%	7%	2,212
Bole Mikael (OP-3)	D-1	4,525	4,636	9,161	49%	51%	711	33	744	96%	4%	9,905
	D-2	4,502	4,706	9,208	49%	51%	919	52	971	95%	5%	10,179
	D-3	4,412	4,679	9,091	49%	51%	759	39	798	95%	5%	9,889
St. Yoseph (OP-4)	D-1	3,212	3,650	6,862	47%	53%	273	29	302	90%	10%	7,164
	D-2	3,217	3,462	6,679	48%	52%	343	35	378	91%	9%	7,057
	D-3	3,380	3,493	6,892	49%	51%	455	33	488	93%	7%	7,380
Addisu Sefer (OP-5)	D-1	2,281	2,414	4,695	49%	51%	790	88	878	90%	10%	5,573
	D-2	2,305	2,396	4,701	49%	51%	840	99	939	89%	11%	5,640
	D-3	2,409	2,441	4,850	50%	50%	829	89	918	90%	10%	5,768
Ersha Sebil (OP-6)	D-1	1,074	1,328	2,402	45%	55%	143	19	162	88%	12%	2,564
	D-2	1,185	1,218	2,398	49%	51%	157	21	178	88%	12%	2,576
	D-3	1,287	1,319	2,606	49%	51%	335	43	378	89%	11%	2,984
Hana Mariam (OP-7)	D-1	428	405	833	51%	49%	115	22	137	84%	16%	970
	D-2	422	395	817	52%	48%	129	29	158	82%	18%	975
	D-3	498	403	901	55%	45%	151	19	170	89%	11%	1,071
Overall		**48,169**	**44,641**	**92,824**	**53%**	**47%**	**9,669**	**849**	**10,518**	**92%**	**8%**	**103,342**

This study considers two ranges of distance for utilization rate computation (outline illustrated in Fig. 4.1)

Case-I: Overpass users and non-users within 100m distance from the facility in both sides (i.e, 200m) All crossing scenarios are can easily be observed (visible) and can be counted within this range of distance unambiguously and pedestrians within this zone are supposed to utilize the facility so that the utilization rate is characterized accurately.

Case-II: Overpass users and non-user pedestrians within half distance of the next pedestrian crossing treatment in both sides (i.e, pedestrians within $X_L/2$ and $X_R/2$ in Figure 4.1) from the overpass facility.

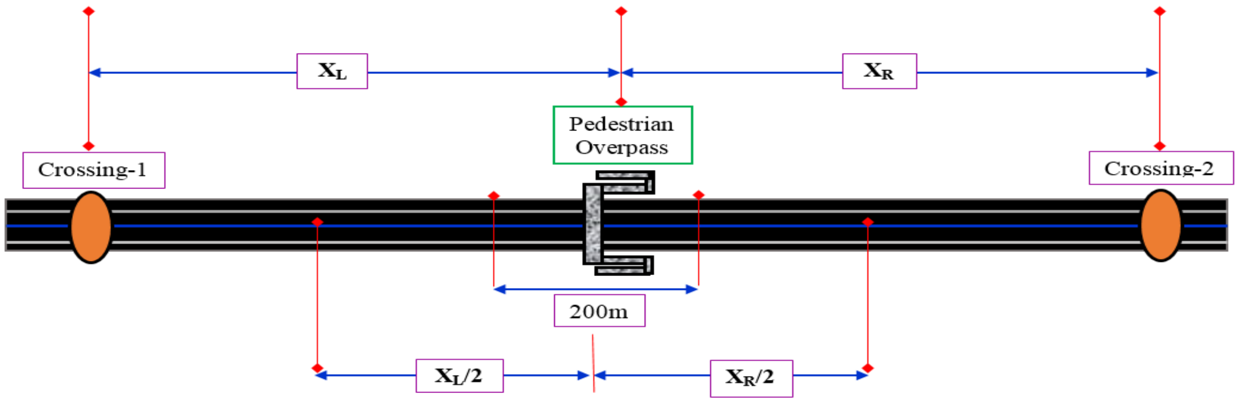


Figure 4.1: Outline of Zones for Pedestrian Counting and Analysis Cases

In Figure 4.1, Crossing-1 and Crossing-2 represent any crossing facility that is legally and operationally allows pedestrians to cross at X_L and X_R distance on the left and right side of an overpass facility under investigation.

The rate of utilization of each overpass (case-I) is illustrated in Table 4.2 below. The result shows that St. Yoseph overpass (OP-4) has the highest average utilization rate of 94.61% followed by Hayat Hospital (OP-2) with 93.58%, Bole Mikael (OP-3) with 91.63% and Ersha Sebil (OP-6) with 91.37% utilization rates. The least three utilization rates were found at Nyala Motors (OP-1), Hana Mariam (OP-7) and Saris Addisu Sefer (OP-5) with 84.99%, 84.60% and 83.89% utilization rates respectively. Elevation difference between carriageways and the metal fences added on the concrete barriers appears to discourage at grade crossing hence a high rate of utilization is attained.

The first four overpasses with high utilization rates have an additional metal fences on the top of the concrete barriers but the last three lack this. The road below St. Yoseph overpass (OP-4) has a carriageway with elevation difference which discourages to jump in addition to the metal fences added to the concrete barriers.

Table 4.2: Utilization Rate of Pedestrian Overpasses along the Addis Ababa Ring Road (Case-I)

Overpasses	Days	Overpass Users 8-Hr count [A]	Non-Users within 200m, 8-Hr count [B]	Rate of Utilization (U_R)	Rate of Utilization (Average)
Nyala Motors (OP-1)	D-1	4,848	792	85.96%	84.99%
	D-2	4,989	809	86.05%	
	D-3	4,194	861	82.97%	
Hayat Hosp. (OP-2)	D-1	2,234	151	93.67%	93.58%
	D-2	2,408	149	94.17%	
	D-3	2,055	157	92.90%	
Bole Mikael (OP-3)	D-1	9,161	744	92.49%	91.63%
	D-2	9,208	971	90.46%	
	D-3	9,091	798	91.93%	
St. Yoseph (OP-4)	D-1	6,862	302	95.78%	94.61%
	D-2	6,679	378	94.64%	
	D-3	6,892	488	93.39%	
Saris Addisu Sefer (OP-5)	D-1	4,695	878	84.25%	83.89%
	D-2	4,701	939	83.35%	
	D-3	4,850	918	84.08%	
Ersha Sebil (OP-6)	D-1	2,402	162	93.68%	91.37%
	D-2	2,398	178	93.09%	
	D-3	2,606	378	87.33%	
Hana Mariam (OP-7)	D-1	833	137	85.88%	84.60%
	D-2	817	158	83.79%	
	D-3	901	170	84.13%	

Non-users within up to half distance of the next crossing facility in both sides were also considered to compute the utilization rate of overpasses (case-II). Distance was used as a factor to convert the number of non-users within the first 100m to represent the rest (where counting had not been carried out).

Table 4.3: Spacing (Distance) Between Pedestrian Facilities along the Addis Ababa Ring Road

From	To	Distance / Spacing (m)	Half distance b/n facilities
Megenagna	Nyala Motors(OP-1)	1500	750
Nyala Motors(OP-1)	Imperial (Bob Marley) Square	700	350
Imperial (Bob Marley) Square	Hayat Hospital Overpass(OP-2)	950	475
Hayat Hospital Overpass(OP2)	Bole Intl Airport	500	250
Bole Mikael (Traffic light)	Bole Mikael Overpass (OP-3)	304	152
Bole Mikael Overpass (OP-3)	St. Yoseph Overpass(OP-4)	2000	1000
St. Yoseph Overpass(OP-4)	Kadisco Square	730	365
Kadisco Square	Saris Addisu Sefer (OP-5)	376	188
Saris Addisu Sefer (OP-5)	Ersha Sebil Overpass (OP-6)	1026	513
Ersha Sebil Overpass (OP-6)	Abo Square	690	345
Kality Interchange	Hana Mariam Overpass (OP-7)	1180	590
Hana Mariam Overpass (OP-7)	Hana Qelebet Bridge	1120	560

Hence the utilization rate (U) in case-II is the ratio of number of pedestrian crossing the Ring Road using the overpass (A) to the total number of pedestrians within half distance of the next pedestrian crossings in both sides (D) plus those who used the overpass (A). Analysis in Case-II requires to determine the volume of pedestrians crossing the road without the overpass within half distance of the next crossing facility (D). This volume of pedestrians to be diverted to the facility was computed by multiplying non-users within the first 100m (actual count) by a distance factors as given in Table 4.4 below.

Logically, volume of illegal crossers would increase as distance from the overpass increases because it requires extra time and effort. Therefore it was assumed that illegal crossing beyond the first 100m at least remains the same or equal for distances beyond it up to half distance to the next facility. Assuming that crossing activity beyond the first 100m to be the same as with that of the actual count within the first 100m, would be sound since there are also places (alongside the study route) where there is no illegal crossing activity at all or it may exceed the first 100m count. Assigning L_i and R_i actual volume of non-user pedestrians (for i^{th} 15-minutes interval) within 100m on the left side and 100m on the right side respectively, calculation of D is as shown in Table 4.4 below. The 8-hour count represents 32 intervals of 15 minutes count; hence **i** runs from 1 to 32.

Sample calculation of D for Nyala Motors (OP-1) is illustrated below at Day-1 count.

- User pedestrians at Nyala Motors overpass (OP-1) from the 8Hr count at Day-1, A = 4,848
- Distance from Megenanga (Crossing-1) to Nyala Motors (OP-1), X_L=1.5km (Table 4.3 & Fig 4.1)
- Distance from Nyala Motors (OP-1) to Imperial (Crossing-2), X_R= 0.7km (Table 4.3 & Fig 4.1)
- Half distance between Megenanga (Crossing-1) and Nyala Motors (OP-1), $X_L/2$=750m (Table 4.4)
- Half distance from Nyala Motors (OP-1) to Imperial Junction (Crossing-2), $X_R/2$= 350m (Table 4.4)

The 1st 15-minute count within the first 100m (from 8:00-8:15AM) on the left and right side are represented as L_1 and R_1, the 2nd count (from 8:15-8:30AM) as L_2 and R_2 and the last (32nd) count (from 5:45PM-6:00PM) as L_{32} and R_{32}. If 100m represents L_i volume of pedestrian counts for a single 15-minute interval on the left side, then 750m would represent $7.5L_i$ pedestrians. Hence a factor of 7.50 and 3.50 are used to represent pedestrian volume up to half distance of the facility from the first 100m actual count on the left and right side respectively.

Table 4.4: Formulas to Compute Volume of Non-Users Within up to Half Distance of the Next Facility

Overpass	Half distance between the overpass and next facility(m)		Diverted pedestrians to the facility, Total non-users (D)
	Left side, ($X_L/2$)	Right side, ($X_R/2$)	
Nyala Motors (OP-1)	750	350	$\Sigma\ (7.50L_i+3.50R_i)$
Hayat Hospital (OP-2)	475	250	$\Sigma\ (4.75L_i+2.50R_i)$
Bole Mikael (OP-3)	152	1000	$\Sigma\ (1.52L_i+10.0R_i)$

St Yoseph Church(OP-4)	1000	365	Σ (10.0L_i+3.65R_i)
Saris Addisu Sefer(OP-5)	188	513	Σ (1.88L_i+5.13R_i)
Ersha Sebil (OP-6)	513	345	Σ (5.13L_i+3.45R_i)
Hana Mariam (OP-7)	590	560	Σ (5.90L_i+5.60R_i)

To illustrate the procedures discussed above, total non-users (D) up to half distance from Nyala Motors overpass (OP-1) in both sides is computed using Equation 4.1 below for Day-1 count.

$$D = \sum_{i=1}^{32} (7.5Li+3.5Ri) \text{ -----------------------} \quad (\mathbf{4.1})$$

$$D = \sum_{i=1}^{32} (7.5*24+3.5*7)+(7.5*36+3.5*11)+ \text{---} +(7.5*33+3.5*2) = 5{,}548$$

The total number of non-user pedestrians to be diverted to Nyala Motors overpass (OP-1) is 5,548 (at Day-1 count). Therefore utilization rate of Nyala Motors overpass (OP-1) is computed as follows.

$$U = \frac{A}{(A+D)} *100, \; U = \frac{4848}{(4848+5548)} *100 = 46.63\%$$

The utilization rates at Hayat Hospital (OP-2), St. Yosef (OP-4), Ersha Sebil (OP-6) and Bole Mikael (OP-3) are relatively best with 81.49%, 72.32%, 71.22% and 69.69% utilization rates respectively. Overpasses with lowest utilization rates are Saris Addisu Sefer (OP-5), Hana Mariam (OP-7) and Nyala Motors (OP-1) with utilization rates of 60.38%, 48.66% and 45.09% respectively.

Higher utilization rate values indicate that the facility accommodates most pedestrians at its vicinity and provides ideal service for pedestrian's supposed to utilize it at farthest distance also. It also shows that the facility is within negotiable walking distance for most pedestrians from the left and right side of it. The utilization rate gets lower as illegal crossing activity increases as distance from the facility increases since no option is available or most pedestrians are reluctant to walk to the facilities.

Table 4.5: Utilization rate of pedestrian overpasses along the Addis Ababa Ring Road (Case-II)

Overpasses	Days	Users 8-Hr count [A]	Non-Users up to Half Distance [D]	Rate of Utilization (U)	Rate of Utilization (Average)
Nyala Motors (OP-1)	D-1	4,848	5,548	46.63%	45.09%
	D-2	4,989	5,696	46.69%	
	D-3	4,194	5,806	41.94%	
Hayat Hospital (OP-2)	D-1	2,234	486	82.13%	81.49%
	D-2	2,408	501	82.78%	
	D-3	2,055	528	79.56%	

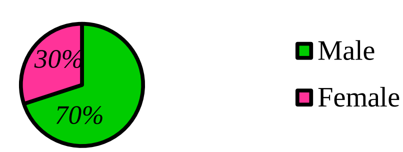
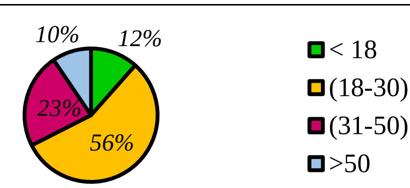
Bole Mikael (OP-3)	D-1	9,161	3,336	73.31%	69.69%
	D-2	9,208	4,724	66.09%	
	D-3	9,091	3,960	69.66%	
St. Yoseph (OP-4)	D-1	6,862	1,966	77.73%	72.32%
	D-2	6,679	2,580	72.14%	
	D-3	6,892	3,381	67.09%	
Saris Addisu Sefer (OP-5)	D-1	4,695	2,993	61.07%	60.38%
	D-2	4,701	3,182	59.63%	
	D-3	4,850	3,175	60.44%	
Ersha Sebil (OP-6)	D-1	2,402	707	77.26%	71.22%
	D-2	2,398	797	75.05%	
	D-3	2,606	1,643	61.33%	
Hana Mariam (OP-7)	D-1	833	798	51.07%	48.66%
	D-2	817	917	47.12%	
	D-3	901	984	47.80%	

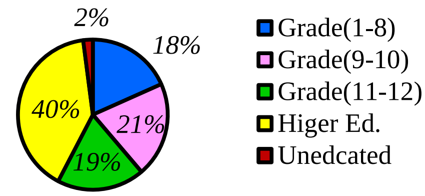
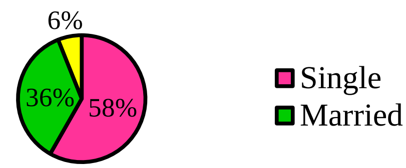
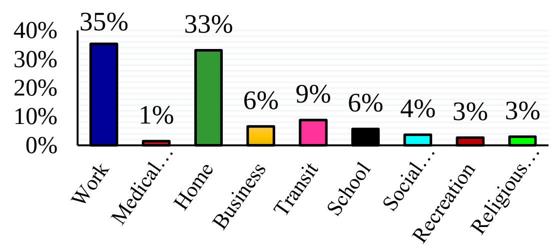
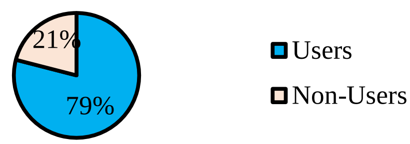
Pedestrians due to various reasons either use or not use an overpass while crossing the Ring Road. Questionnaire was distributed to pedestrian of two types (i.e users and non-users of overpasses) to assess how they perceive of crossing the Ring Road without overpass, to identify factors that affect pedestrians either to use or not to use the facilities while crossing. Pedestrians were also asked to recommend improvement measures to enhance the utilization rate and performance of the facilities and how to accommodate and satisfy the needs of diverse pedestrians like disabled, elderly and children.

Profile of Pedestrians Participated in the Questionnaire Survey

The sample respondents involved in the survey have diverse educational background, age, gender, marital status and were travelling for different trip purpose.

Table 4.6: Profile of Pedestrians Participated in the Questionnaire Survey

Attributes	Categories	Number	Percent	Charts for Illustration
Gender	Male	744	70%	
	Female	319	30%	
	Total	1063	100%	
Age Group	<18	125	12%	
	18 – 30	595	56%	
	31 – 50	244	23%	
	>50	101	10%	
	Total	1063	100%	
Educational Background	Grades(1 – 8)	195	18%	

	Grades(9 – 10)	217	21%	
	Grades(11 – 12)	201	19%	
	Higher Education	428	40%	
	Uneducated	22	2%	
	Total	1063	100%	
Marital Status	Single	619	58%	
	Married	380	36%	
	Others (Divorced, Widowed)	64	6%	
	Total	1063	100%	
Trip Purpose	Work	376	35%	
	Medical Case	15	1%	
	Home	352	33%	
	Business/Shopping	69	6%	
	Transit/ Transport	93	9%	
	School	60	6%	
	Social Obligation	39	4%	
	Recreation	28	3%	
	Religious Center	31	3%	
	Total	1063	100%	
Number of Questionnair e Papers	Distributed	1083	-	----
	Returned	1063	98%	
Means of Crossing	Overpass User	840	79%	
	Overpass Non-Users	223	21%	
	Total	1063	100%	

4.1.1 Factors Affecting Pedestrians Not To Use Overpasses While Crossing

4.1.1.1 Risk Perception of Pedestrians Crossing the Ring Road without Overpasses

Pedestrians were asked how they perceive crossing the Ring Road at grade, i.e without using overpasses. Out of 1063 participants, 75% (798) of pedestrian perceive it to be ‘Very Dangerous’. Pedestrians who perceive it as ‘Dangerous’, ‘Safe’ and ‘Very Safe’ are 9%, 7% and 9% respectively. If pedestrians perceive illegal crossing as risky and unsafe, they will refrain from the activity and hence the utilization rate of facilities will be high. Though most pedestrian comprehend the risk of illegal crossing, perceive it ‘Very Dangerous’ and know that it is punishable by the traffic law of the country (79% of users and 70% non-users are aware of the law), the problem is still taking the lives of many pedestrians in the city.

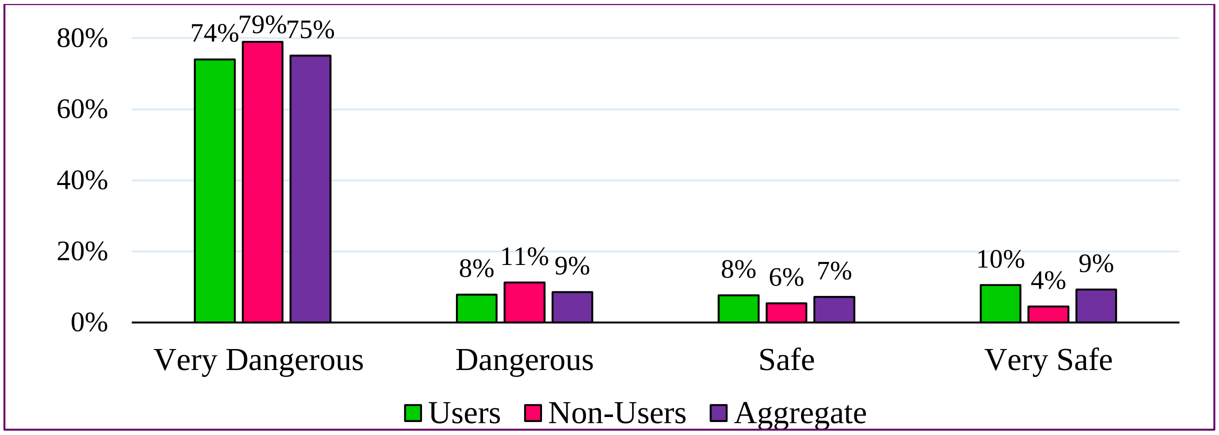


Figure 4.2: Perception of Pedestrians about Crossing the Ring Road without Overpasses

4.1.1.2 Awareness of Pedestrians

It is undisputable that awareness (of traffic laws) is a decisive factor either to use or not to use pedestrian facilities at hand. Pedestrians were asked a 'YES/NO' question whether they know crossing the Ring Road at grade is punishable by the traffic law of Ethiopia. Out of the 1063 (840 users & 223 non-users) participants, 78% (824) of them responded 'YES', and 22% (239) responded 'NO'. The lack of awareness is higher in the case of non-user pedestrians.

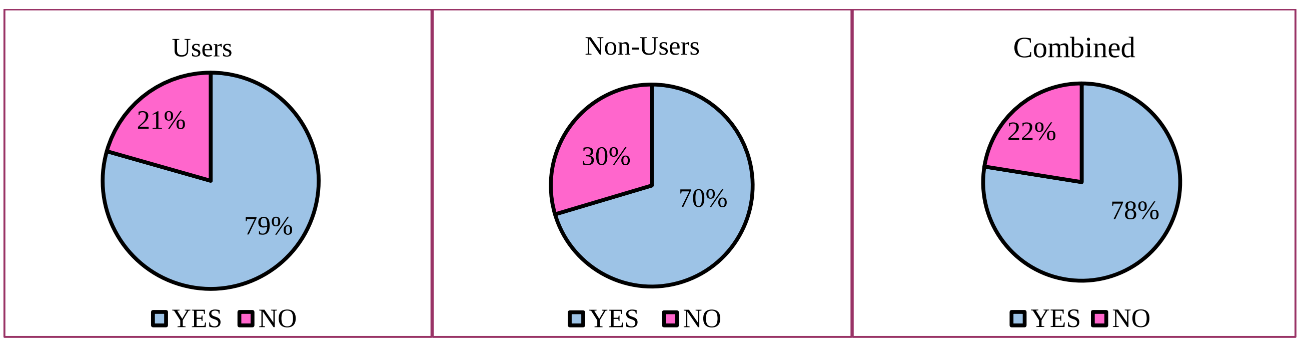


Figure 4.3: Pedestrians Response Weather They Know It Is Punishable To Cross at Grade

4.1.1.3 Factors Affecting Pedestrian Decision in Choosing How to Cross the Road

In deciding either to use or not to use an overpass while crossing the Ring Road, pedestrians consider different factors associated with the two alternatives. Pedestrians were asked what mostly influence their judgment or decision in using/not using a pedestrian overpass. Users and non-users prioritize different aspects in the decision making process. The result shows that users prioritize ***safety*** whereas non-users prioritize ***time*** in their decision to select crossing alternatives. The top three preferences considered by users are Safety, Distance and Time which were selected by 55%, 15% and 10% of user respondents; whereas the top three preferences selected by non-users are Time, Distance and Safety which were selected by 37%, 24% and 20% of non-users.

The preferences are reversed as the priorities of user pedestrians is their Safety and that of non-users is Time. This analysis result shows that user pedestrians prefer to use overpasses for the sake of their safety no matter how long it takes, regardless of its distance from their origin-destination line, uncomfortable and unattractiveness of the facilities. Non-user pedestrians put their safety as last option by prioritizing the time that possibly could be saved while crossing at grade level. There are also factors with negligible effect in the decision making process such as attractiveness of the facilities, energy, vehicular traffic volume at grade level and comfort as only 2%, 2%, 4% and 5% of respondents selected them.

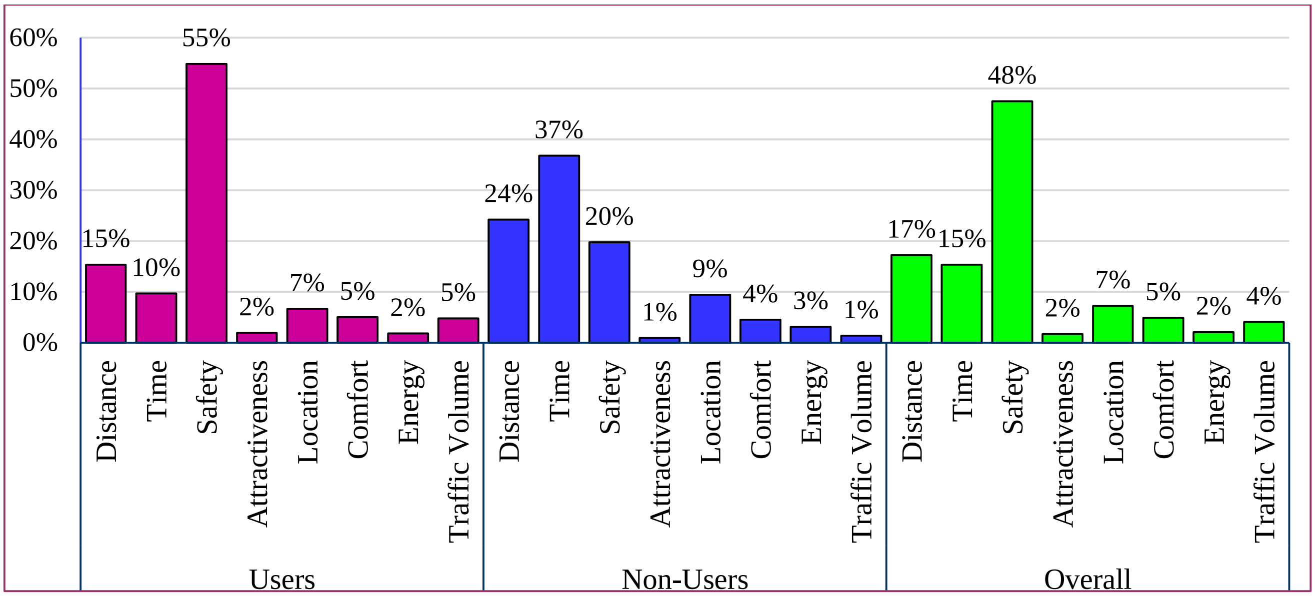


Figure 4.4: What Factors Pedestrian Prioritize in Deciding either to Use or Not to Use Overpasses

4.1.1.4 Miscellaneous Factors Affecting Pedestrians Not To Use Overpasses

From different literatures, factors that possibly hinder utilization of the overpass facilities were extensively identified and reviewed. A question was designed to identify factors that made pedestrians not to use overpass facilities and respondents were requested to select and tick as well as write (if not on the list) the possible factors. The majority of pedestrians responded that time saving, lack of awareness, absence of law enforcement and the facility being far from their origin/destination point are the main reasons that made them not to use the facilities. These responses account to 27%, 22%, 18% and 11% of overall participants. Vibration (shaking) of the overpasses, low volume of traffic at-grade, poor attractiveness of the facilities and congestion on the facilities are not considered as significant factors for not using the overpasses as only 1%, 1%, 2% and 2% of survey participants, respectively, replied for these.

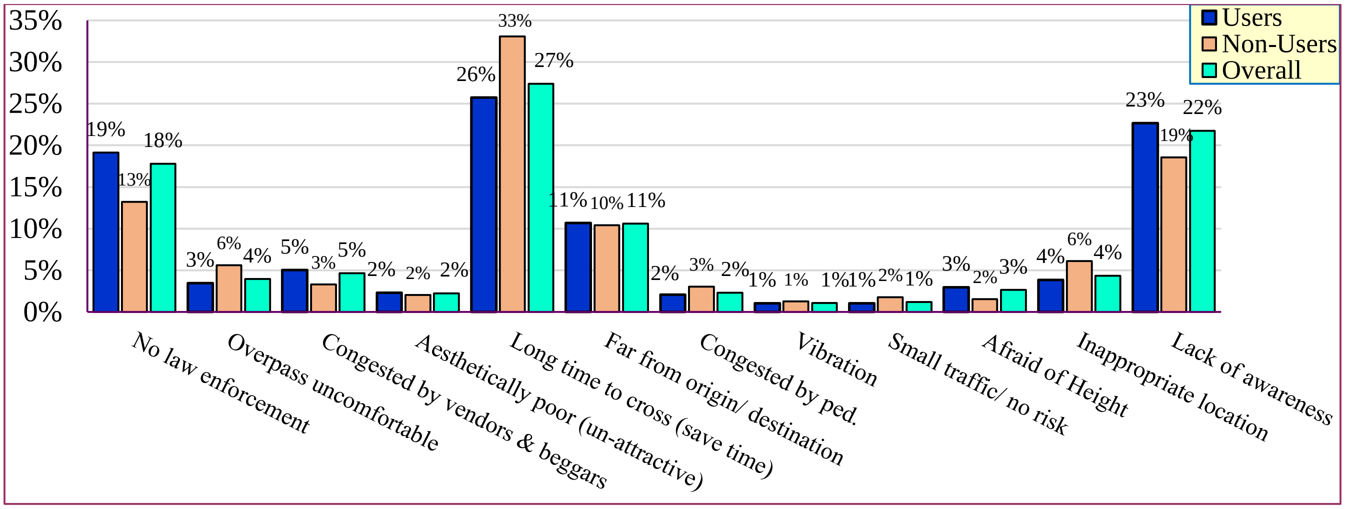


Figure 4.5: Factors Affecting Pedestrians not to Use Overpasses

The case by case analysis to find out the factors that affect pedestrians from using overpasses is illustrated in Figure 4.5. It shows that long crossing time is the leading factor followed by inappropriate location, lack of awareness, absence of law enforcement, facility being far from origins and destination. Table 4.7 shows the ranks (from 1 to 12) of the factors based on frequency of survey responses of both users and non-users at each location.

Table 4.7: Ranking of Factors Affecting Pedestrians not to Use Overpasses

Overpasses	Pedestrian Category	No Law Enforcement	Overpass Uncomfortable	Congestion by Vendors & Beggars	Unattractivene ss	Long Crossing Time	Far from Origin/ Destination	Congested by Pedestrians	Vibration	Small traffic/ No Risk	Afraid of Height	Inappropriate Location	Lack of Awareness
Nyala Motors (OP-1)	Users	3	7[b]	6[a]	10[c]	2	4	9	12	11[c]	8[b]	5[a]	1
	Non-Users	2	5	6	9[b]	1	3	10[b]	12	11[b]	8[a]	7[a]	4
Hayat Hospital (OP-2)	Users	3	6	5	10[a]	2	4	7	12[b]	11[b]	8	9[a]	1
	Non-Users	3	4	5[b]	8[c]	1[a]	**	6[b]	**	**	**	7[c]	2[a]
Bole Mikael (OP-3)	Users	3	8[a]	5	9[b]	2	4	6[a]	12[c]	11[c]	10[b]	7[a]	1
	Non-Users	3	**	**	**	1	6[a]	5[a]	4	**	**	**	2
St Yoseph Church (OP-4)	Users	3	6	5	10[b]	1	4	8[a]	12[b]	11[b]	9[a]	7	2
	Non-Users	4	6	8[a]	9[a]	1	3	10[a]	12	7	11[a]	5	2
Saris Addisu Sefer (OP-5)	Users	3	7	4	8	1	5[a]	9[a]	10[a]	12	6[a]	11	2
	Non-Users	2	10[a]	6[a]	5	1	4	7[a]	12[a]	8[a]	11[a]	9[a]	3
Ersha Sebil (OP-6)	Users	3	8[a]	9[a]	7	1	4	11	**	10	6	5	2
	Non-Users	5[a]	6[a]	7[b]	**	1	4	8[b]	**	**	9[b]	3	2
Hana Mariam (OP-7)	Users	2	5[a]	11[c]	6[a]	1	4	10[c]	8[b]	12	9[b]	7	3
	Non-Users	3[a]	5	8[a]	9[b]	1	4	6	10[b]	11[b]	**	7[a]	2[a]

*The superscript letters (a, b, c, d) show that factors have the same rank weighed equally by pedestrians, ** Factors that have not considered as a hindering factor not to use the overpasses at all.*

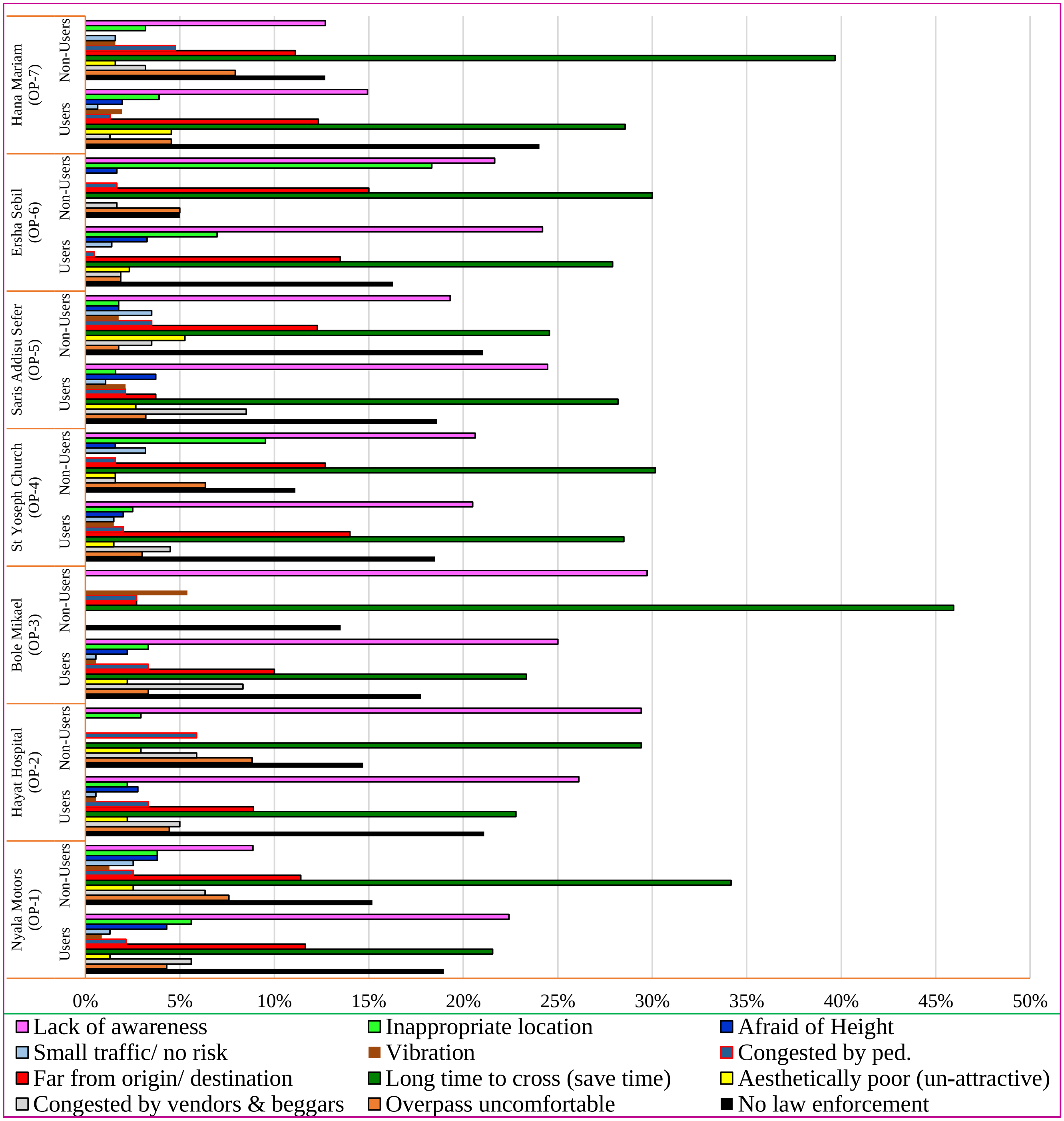


Figure 4.6: Factors Affecting Pedestrians Not to Use Overpasses (Case by Case)

4.1.1.5 Effect of Illegal Vendors and Beggars along the Pedestrian Overpasses

Tremendous amount of street vendors and beggars are noticeable in the city especially where pedestrian volume is high such as market areas, transport stations and religious centers. The effect is noteworthy even on pedestrian overpass facilities where a lot of commodities are wide spread for sale.

Figure 4.7: Illegal Vendors and Beggars Over Pedestrian Overpasses along The Addis Ababa Ring Road

Pedestrians were asked to rate the effect of vendors and beggars as the influence of these two might also make them to avoid the facilities while crossing. The response analysis was made case by case for each overpass since the effect might differ from place to place. The effect is minimum on Hana Mariam (OP-7) and Ersha Sebil (OP-6). Overall, 156 pedestrians (118 users plus 38 non users) were surveyed at Hana Mariam overpass and pedestrians rated the effect of beggars and vendors on the facility as ‘NO’, ‘Slight’, ‘High’ and ‘Very High’ were 61% (93), 19% (30), 12% (21) and 8%(12) respectively. This result shows that the effect of illegal vendors and beggars is small on Hana Mariam overpass (OP-7) as compared to the others. The effect is highest on overpasses at Saris Addisu Sefer (OP-5) followed by Bole Mikael (OP-3) and St. Yoseph (OP-4). The effect is higher where there are religious centers, market areas, transport stations and terminals.

Table 4.8: The Effect of Vendors and Beggars (as rated by Pedestrians)

Overpasses	Users				Total	Non-Users				Total	Overall				Total
	No	Slight	High	Very High		No	Slight	High	Very High		No	Slight	High	Very High	
Nyala Motors(OP-1)	17	53	20	22	112	8	21	7	5	41	25	74	27	27	153
Hayat Hospital(OP-2)	31	42	26	13	112	5	8	1	2	16	36	50	27	15	128
Bole Mikael(OP-3)	19	41	33	33	126	1	15	5	3	24	20	56	38	36	150
St Yoseph (OP-4)	21	49	31	22	123	11	14	7	5	37	32	63	38	27	160
Saris Addisu (OP-5)	16	46	29	33	124	7	7	9	6	29	23	53	38	39	153
Ersha Sebil(OP-6)	46	49	11	19	125	17	11	6	4	38	63	60	17	23	163
Hana Mariam(OP-7)	71	23	14	10	118	22	7	7	2	38	93	30	21	12	156
Total	221	303	164	152	840	71	83	42	27	223	292	386	206	179	1063
Percent (%)	26%	36%	20%	18%	100%	32%	37%	19%	12%	100%	27%	36%	19%	17%	100%

overpasses	Users				Total	Non-Users				Total	Overall				Total
	No	Slight	High	Very High		No	Slight	High	Very High		No	Slight	High	Very High	
Nyala Motors(OP-1)	15%	47%	18%	20%	100%	20%	51%	17%	12%	100%	16%	48%	18%	18%	100%
Hayat Hospital(OP-2)	28%	38%	23%	12%	100%	31%	50%	6%	13%	100%	28%	39%	21%	12%	100%
Bole Mikael(OP-3)	15%	33%	26%	26%	100%	4%	63%	21%	13%	100%	13%	37%	25%	24%	100%

St Yoseph (OP-4)	17%	40%	25%	18%	100%	30%	38%	19%	14%	100%	20%	39%	24%	17%	100%
Saris Addisu (OP-5)	13%	37%	23%	27%	100%	24%	24%	31%	21%	100%	15%	35%	25%	25%	100%
Ersha Sebil(OP-6)	37%	39%	9%	15%	100%	45%	29%	16%	11%	100%	39%	37%	10%	14%	100%
Hana Mariam(OP-7)	60%	20%	12%	8%	100%	59%	18%	18%	5%	100%	60%	19%	13%	8%	100%

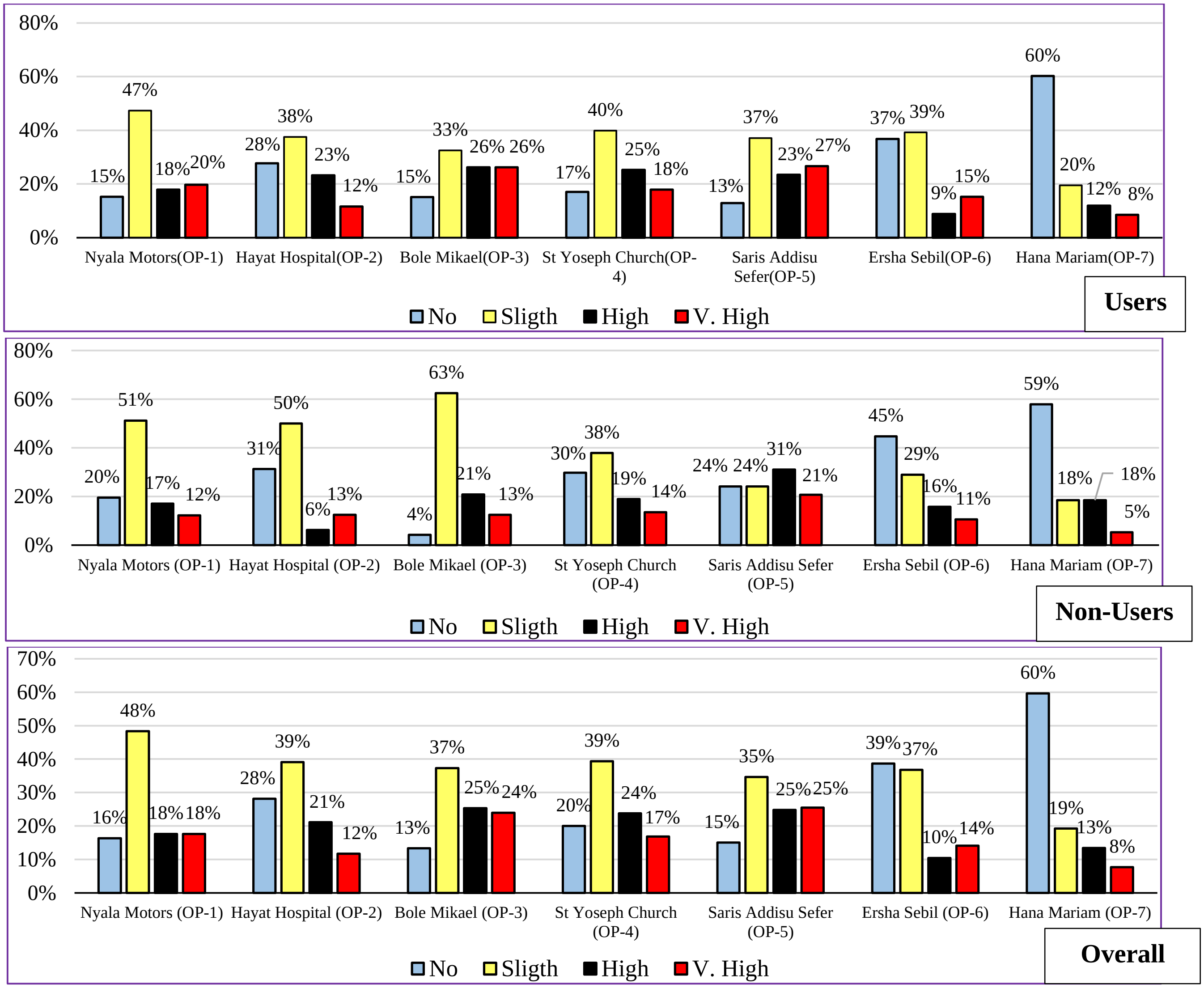


Figure 4.8: How Pedestrians Rated the Effect of Vendors and Beggars on Overpasses

4.2 Analysis of Performance of Pedestrian Overpasses

4.2.1 Pedestrian Level of Service (P-LOS)

The level of service of the facilities was computed by taking in to account of the volume of pedestrians crossing the Ring Road using overpass only (Case-I), using the overpass plus without the overpass within 200m range of distance (Case-II) and using the overpass and non-users up to half distance of next facility (Case-III).

P-LOS Based on Flow Rate (V_P)

The following are the steps involved in extracting the pedestrian flow rate data:

i. The volume of pedestrians every 15-minutes of the peak period was counted manually (for 8-hours) for three weekdays (labelled as D-1, D-2 and D-3) at each site. Manual counts of the pedestrians entering and leaving the facility and non-users within 200m distance for every 15-minutes from 8:00AM-12:00PM in the morning and 2:00PM -6:00PM in the afternoon was conducted.

ii. The peak 15-minutes volume was observed. Dividing it by the effective width of the facility gives the flow per meter. This flow value per minutes gives the flow rate in pedestrians/minutes/meter.

$$V_P = \left(\frac{V_{15}}{15xW_E}\right) \quad \text{(4.2)}$$

Where: V_P = ped. flow rate (p/min/m), V_{15} = peak 15-min flow rate (p/15-min), and W_E = effective width. The total width (W_T) of the overpasses was measured from the face of handrail to face of handrail in the field using tape and found to be 2.75m. The effective width (W_E) was also measured in the field by leaving out the curb extensions at the bottom of the hand rails (where pedestrians avoid to step on) and was found to be 2.50m. Moving pedestrians shy away from the curb and do not press closely against the hand rails. Therefore, this unused space was discounted.

Table 4.9: Volume of Pedestrians during the Peak and Off-Peak Periods, Overpass Users Only (Case-I)

Overpass	Days	15-minute Volumes				Hourly Volumes			
		Morning		Afternoon		Morning		Afternoon	
		Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Nyala Motors (OP-1)	D-1	391	**79***	289	**83***	1,037	**344***	997	385
	D-2	**397***	76	**293***	79	**1,201***	336	**1,004***	**385***
	D-3	338	69	221	48	917	293	800	294
Hayat Hosp. (OP-2)	D-1	103	**44***	**104***	**50***	345	**211***	343	**240***
	D-2	**110***	44	103	43	**385***	207	**361***	233
	D-3	94	44	97	46	311	199	318	217
Bole Mikael (OP-3)	D-1	400	172	526	152	1,394	825	1,690	733
	D-2	385	177	511	**159***	**1,411***	**873***	1,611	775
	D-3	**404***	**179***	**538***	153	1,357	815	**1,767***	**781***
St Yoseph (OP-4)	D-1	**291***	119	449	**143***	945	**510***	1,355	**642***
	D-2	288	**120***	427	137	930	505	1,267	607
	D-3	291	115	**456***	143	**968***	495	**1,367***	619
Saris Add. Sefer (OP-5)	D-1	202	122	174	67	725	541	**660***	367
	D-2	**203***	117	177	72	723	538	656	376
	D-3	203	**126***	**184***	**81***	**764***	**557***	657	**392***
Ersha Sebil (OP-6)	D-1	172	37	**150***	52	407	172	443	237
	D-2	**191***	32	124	55	**514***	156	437	241
	D-3	172	**39***	137	**70***	427	**198***	**454***	**298***

Hana Mariam (OP-7)	D-1	56	8	**69***	4	175	39	213	55
	D-2	**68***	6	63	5	**185***	34	198	57
	D-3	60	**10***	69	**13***	174	**44***	**232***	**62***

***** - *Peak values used for analysis (selected from the three days count for each pedestrian overpass)*

Sample calculation of pedestrian unit flow rate and LOS for Nyala Motors overpass (OP-1) for the morning peak period is illustrated below.

The peak 15-minute volumes were 391 at Day-1, 397 at Day-2 and 338 at Day-3 count. Hence, for analysis purpose the maximum peak 15-minute volume in the morning peak period (V_{15}) = 397 (from Day-2 count)

Effective width of the overpass slab/deck (W_E) = 2.5m, Effective width of the stairway (W_E) = 2.5m

$$V_P = \left(\frac{V_{15}}{15xW_E}\right) = \left(\frac{397\,\text{Pedestrians}}{(15\text{-minutes})x(2.5\text{m})}\right) = 10.59 \approx 11\,\text{pedestrians /minutes/meter}$$

A flow rate of 11p/min/m is classified as a PLOS-A from HCM2000 level of service criteria tables. This is true both for the stairway and the slab/deck of the pedestrian overpass. The same procedure was followed to compute the flow rate values along with LOS in the morning and afternoon peak and off-peak periods.

The LOS analysis for all the overpasses fall to category of PLOS-A when only user pedestrians are considered (Case-I). The result shows that user pedestrians move in desired paths, select walking speeds freely and conflicts between pedestrians is unlikely.

Table 4.10: Pedestrian Level of Service based on Flow Rate (Case-I)

Overpasses, Flow Rates (V_P) values and P-LOS		Slab/Deck				Stairway			
		Morning		Afternoon		Morning		Afternoon	
		Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Nyala Motors (OP-1)	V_P	11	3	8	3	11	3	8	3
	P-LOS	A	A	A	A	A	A	A	A
Hayat Hospital (OP-2)	V_P	3	2	3	2	3	2	3	2
	P-LOS	A	A	A	A	A	A	A	A
Bole Mikael (OP-3)	V_P	11	5	15	5	11	5	15	5
	P-LOS	A	A	A	A	A	A	A	A
St Yoseph Church (OP-4)	V_P	8	4	13	4	8	4	13	4
	P-LOS	A	A	A	A	A	A	A	A
Saris Addisu Sefer (OP-5)	V_P	6	4	5	3	6	4	5	3
	P-LOS	A	A	A	A	A	A	A	A
Ersha Sebil (OP-6)	V_P	6	2	4	2	6	2	4	2
	P-LOS	A	A	A	A	A	A	A	A
Hana Mariam (OP-7)	V_P	2	1	2	1	2	1	2	1
	P-LOS	A	A	A	A	A	A	A	A

To see how the level of service of the facilities vary if illegal crossings are diverted to the facilities, non-user pedestrians (within 200m range of distance) are added to the 15-minute users volume and same analysis had been carried out (Case-II).

Table 4.11: Volume of Pedestrians during the Peak and Off-Peak Periods (Case-II)

Overpass	Days	15-Minute Volumes				Hourly Volumes			
		Morning		Afternoon		Morning		Afternoon	
		Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Nyala Motors (OP-1)	D-1	422	**87***	345	**98***	1,188	**396***	1,174	**457***
	D-2	**429***	84	**351***	96	**1,330***	381	**1,209***	452
	D-3	380	79	268	59	1,080	347	981	366
Hayat Hosp. (OP-2)	D-1	109	47	**112***	**52***	372	**237***	358	**252***
	D-2	**114***	**48***	107	46	**410***	228	**381***	247
	D-3	100	47	104	48	342	223	338	227
Bole Mikael (OP-3)	D-1	413	187	**576***	172	1,457	927	1,811	806
	D-2	406	**203***	561	**188***	**1,525***	**984***	1,750	**879***
	D-3	**422***	198	571	170	1,454	918	**1,870***	860
St Yoseph (OP-4)	D-1	298	130	472	147	979	545	1,419	662
	D-2	298	**131***	451	143	986	545	1,332	635
	D-3	**305***	128	**484***	**155***	**1,023***	**548***	**1,456***	**664***
Saris Addisu (OP-5)	D-1	227	133	203	93	846	615	765	463
	D-2	227	128	202	99	855	611	**781***	488
	D-3	**244***	**136***	**216***	**109***	**908***	**634***	772	**498***
Ersha Sebil (OP-6)	D-1	175	41	**157***	56	419	186	477	252
	D-2	**193***	36	137	56	**532***	172	477	266
	D-3	187	**49***	148	**79***	483	**239***	**514***	**349***
Hana Mariam (OP-7)	D-1	63	8	**75***	5	193	45	257	70
	D-2	**82***	6	69	7	**213***	40	241	76
	D-3	71	**11***	74	**18***	201	**54***	**259***	**85***

***** - *Peak values used for analysis (selected from the three days count for each pedestrian overpass)*

Sample calculation of pedestrian unit flow rate (V_P) and LOS for Nyala Motors overpass (OP-1) for the morning peak period is illustrated below.

Peak 15-minute pedestrian volume in the morning period were 422 at Day-1, 429 at Day-2 and 380 at Day-3 counts. Maximum of the three is selected for analysis which is (V_{15}) = 429 Effective width of the overpass slab/deck (W_E) = 2.5m, Effective width of the stairway (W_E) = 2.5m

$$V_P = \left(\frac{V_{15}}{15xW_E}\right) = \left(\frac{429\,\text{Pedestrians}}{(15\text{-minutes})x(2.5\text{m})}\right) = 11.44 \approx 12\,\text{pedestrians /minutes/meter}$$

From the HCM2000 a flow rate value of 12p/min/m is classified as a PLOS-A. This is true both for the stairway and the slab/deck of the overpass.

Even though non-users within 200m range of distance are considered (Case-II), the LOS analysis of all the overpasses fall to PLOS-A category which is similar to the analysis carried out in Case-I. This result indicates that, in addition to user pedestrians, the overpasses can accommodate non-user pedestrians (within 200m) with acceptable LOS and pedestrians move in desired paths, select walking speeds freely and conflicts between pedestrians is unlikely.

Table 4.12: Pedestrian Level of Service Based on Flow Rate (Case-II)

Overpasses, Flow Rates (V_P) values and P-LOS		Slab/Deck				Stairway			
		Morning		Afternoon		Morning		Afternoon	
		Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Nyala Motors (OP-1)	V_P	12	3	10	3	12	3	10	3
	P-LOS	A	A	A	A	A	A	A	A
Hayat Hospital (OP-2)	V_P	4	2	3	2	4	2	3	2
	P-LOS	A	A	A	A	A	A	A	A
Bole Mikael (OP-3)	V_P	12	6	16	6	12	6	16	6
	P-LOS	A	A	A	A	A	A	A	A
St Yoseph Church (OP-4)	V_P	9	4	13	5	9	4	13	5
	P-LOS	A	A	A	A	A	A	A	A
Saris Addisu Sefer (OP-5)	V_P	7	4	6	3	7	4	6	3
	P-LOS	A	A	A	A	A	A	A	A
Ersha Sebil (OP-6)	V_P	6	2	5	3	6	2	5	3
	P-LOS	A	A	A	A	A	A	A	A
Hana Mariam (OP-7)	V_P	3	1	2	1	3	1	2	1
	P-LOS	A	A	A	A	A	A	A	A

The LOS analysis in case-III is intended to figure out how the level of service of the overpass facilities vary when illegal crossings within up to half distance of next pedestrian facility are diverted to the overpasses. For that matter, non-user pedestrians (within half distance to the next facility in both sides) are added to the 15-minutes user pedestrian volumes and same analysis had been carried out (Case-III).

Table 4.13: Volume of Pedestrians during the Peak and Off-Peak Periods (Case-III)

Overpass	Days	15-minute Volumes				Hourly Volumes			
		Morning		Afternoon		Morning		Afternoon	
		Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Nyala Motors (OP-1)	D-1	596	139	697	172	2,074	**708***	2,237	**869***
	D-2	**623***	128	**733***	**193***	**2,089***	649	**2,442***	864
	D-3	617	**140***	592	115	2,028	658	2,034	750
Hayat Hosp. (OP-2)	D-1	125	56	**129***	**55***	428	**294***	402	274
	D-2	**128***	**59***	115	53	**469***	274	**431***	**284***
	D-3	116	58	117	53	411	284	393	249
Bole Mikael (OP-3)	D-1	479	229	704	216	1,804	1,207	2,272	997
	D-2	562	**318***	**740***	**293***	**2,077***	**1,398***	**2,306***	**1,238***
	D-3	**572***	267	690	230	1,920	1,362	2,297	1,122
St Yoseph (OP-4)	D-1	336	145	**662***	177	1,139	700	1,805	798
	D-2	374	160	610	178	1,280	753	1,739	817
	D-3	**418***	**179***	660	**205***	**1,359***	**828***	**2,016***	**904***

Saris Addisu (OP-5)	D-1	299	149	306	141	1,095	761	1,102	671
	D-2	315	144	310	152	1,121	776	**1,126***	**746***
	D-3	**344***	**155***	**312***	**159***	**1,217***	**816***	1,103	744
Ersha Sebil (OP-6)	D-1	184	43	179	64	460	225	604	302
	D-2	200	43	175	59	593	221	620	340
	D-3	**242***	**70***	**198***	**100***	**681***	**371***	**733***	**476***
Hana Mariam (OP-7)	D-1	96	8	**172***	10	278	69	475	143
	D-2	**149***	6	171	17	**346***	69	**476***	154
	D-3	123	**16***	120	**42***	330	**133***	389	**196***

***** - *Peak values used for analysis (selected from the three days count for each pedestrian overpass)*

Sample calculation of pedestrian unit flow rate (V_P) and LOS for the Nyala Motors overpass (OP-1) in the afternoon peak period is illustrated below.

In the afternoon peak periods, the 15-minutes volume recorded were 697, 733 and 592 from Day-1, Day-2 and Day-3 counts. The maximum Peak 15-minute pedestrian volume was selected for analysis, (V_{15}) = 733. Effective width of the overpass slab/deck (W_E) = 2.5m, Effective width of the stairway (W_E) = 2.5m

$$V_P = \left(\frac{V_{15}}{15xW_E}\right) = \left(\frac{733\,\text{Pedestrians}}{(15\text{-minutes})x(2.5\text{m})}\right) = 19.55 \approx 20\,\text{ped/min/m}\ (\text{PLOS-B})$$

From the HCM2000, a flow rate value of 20p/min/m is classified as a PLOS-B.

In the morning and afternoon peak periods, the slab/deck and stairway of Nyala Motors (OP-1) attain a P-LOS of 'B'. In the afternoon peak periods, the slab/deck and stairway of the two overpasses i.e Bole Mikael (OP-3) and St. Yosef (OP-4), attain a level of service 'B' while the other overpasses remind to operate at PLOS-A. The result shows that in addition to user pedestrians, the overpasses along the study route can accommodate non-users within up to half distance of the next facilities without exceeding a P-LOS of 'B'. At this condition, there is enough space to select walking speeds, bypass other pedestrians and to avoid crossing conflicts. Pedestrians begin to be aware of other pedestrians and to respond to their presence when selecting a walking path.

Table 4.14: Pedestrian Level of Service Based on Flow Rate (Case-III)

Overpasses, Flow Rates (V_P) values and P-LOS		Slab/Deck				Stairway			
		Morning		Afternoon		Morning		Afternoon	
		Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Nyala Motors (OP-1)	V_P	17	4	20	6	17	4	20	6
	P-LOS	B	A	B	A	B	A	B	A
Hayat Hospital (OP-2)	V_P	4	2	4	2	4	2	4	2
	P-LOS	A	A	A	A	A	A	A	A
Bole Mikael (OP-3)	V_P	16	9	20	8	16	9	20	8
	P-LOS	A	A	B	A	A	A	B	A
St. Yoseph (OP-4)	V_P	12	5	18	6	12	5	18	6
	P-LOS	A	A	B	A	A	A	B	A

Saris Addisu Sefer (OP-5)	V_P	10	5	9	5	10	5	9	5
	P-LOS	A	A	A	A	A	A	A	A
Ersha Sebil (OP-6)	V_P	7	2	6	3	7	2	6	3
	P-LOS	A	A	A	A	A	A	A	A
Hana Mariam (OP-7)	V_P	4	1	5	2	4	1	5	2
	P-LOS	A	A	A	A	A	A	A	A

In general, the LOS analysis result (from the above three cases) clearly indicate that the pedestrian overpass facilities along the Addis Ababa Ring Road provide adequate service with PLOS-A or B and can accommodate all pedestrians (up to half distance to the next facility) regardless of other problems like inappropriate utilization, large spacing, location inappropriateness, poor design and accessibility for disabled and elderly pedestrians etc.

P-LOS Based on Average Pedestrian Space (A_P)

Pedestrian facility designers use body depth and shoulder breadth for minimum space standards. A simplified body ellipse of 0.5m x 0.6m with a total area of 0.3m^2 is used as the basic space for a single pedestrian as this represents the practical minimum for standing pedestrians. In evaluating pedestrian facility, an area of 0.75 m^2 is used as the buffer zone for each pedestrian (HCM2000).

The pedestrian unit flow rate can be related to pedestrian space and speed using equation 4.7 below:

$$A_P = \left(\frac{S_P}{V_P}\right) \text{------------------------------------} \quad \textbf{(4.3)}$$

Where: A_P= peds. space (m^2/p), S_P = ped. speed (m/min), and V_P = pedestrian flow per unit width (p/m/minutes).

PLOS for the stairways was computed by considering the ascending and descending speed independently.

Table 4.15: Pedestrian Speed along the Overpasses

Overpass	Pedestrian Speed (meter/minutes)		
	Stair Ascending	Deck/ Slab	Stair Descending
Nyala Motors (OP-1)	66.2	72.9	67.6
Hayat Hospital (OP-2)	70.7	77.9	72.2
Bole Mikael (OP-3)	62.4	68.7	63.7
St Yoseph Church (OP-4)	66.6	73.4	68.0
Saris Addisu Sefer (OP-5)	69.2	76.3	70.7
Ersha Sebil (OP-6)	64.6	71.2	66.0
Hana Mariam(OP-7)	67.7	74.6	69.1

Sample calculation of average pedestrian space is illustrated below for Nyala Motors overpass (OP-3) for the slab/deck and stairway (considering ascending and descending speed).

- Speed of pedestrians (deck/slab) = 72.9 meters/min (from Table 4.15)
- Speed of pedestrians (Ascending on the stairway) = 66.2 meters/min (from Table 4.15)
- Speed of pedestrians (Descending on the stairway) = 67.6 meters/min (from Table 4.15)
- Flow rate in the morning peak period 10.59≈ 11p/min/m (from Table 4.10)
- Flow rate in the afternoon peak period= 7.81 ≈ 8 p/min/m (from Table 4.10)
- Flow rate in the morning peak period (on the stairway) 10.59≈11p/min/m (from Table 4.10)
- Flow rate in the afternoon peak period (on the stairway) 7.81 ≈ 8 p/min/m (from Table 4.10)

Average space in the morning peak period (deck/slab):

$$A_P = \left(\frac{S_P}{V_P}\right) = \left(\frac{72.9\,m/min}{10.59\,p/min/m}\right) = 6.9\,m^2/p, \text{ (PLOS category A)}$$

Average pedestrian space in the afternoon peak period (deck/slab):

$$A_P = \left(\frac{72.9\,m/min}{7.81\,p/min/m}\right) = 9.3\,m^2/p, \text{ (PLOS category A)}$$

Average pedestrian space in the morning peak period (Stairway ascending):

$$A_P = \left(\frac{66.2\,m/min}{10.59\,p/min/m}\right) = 6.3\,m^2/p, \text{ (PLOS category A)}$$

Average pedestrian space in the morning peak period (Stairway descending):

$$A_P = \left(\frac{67.6\,m/min}{10.59\,p/min/m}\right) = 6.4\,m^2/p, \text{ (PLOS category A)}$$

In the afternoon peak period, Bole Mikael overpass (OP-3) attains an average pedestrian space of 4.8m^2/p, which is categorized as PLOS-B, whereas on the rest times of the day, its level of service is found to be PLOS-A. The facilities, in general, provide adequate pedestrian space categorized as PLOS-A or B when only user pedestrians are considered (case-I). The results indicate that all the pedestrian overpasses along the study route fulfill the requirement of basic area for standing pedestrian (0.3 m^2) and an area used to evaluate pedestrian facility (0.75m^2) as a buffer zone for each pedestrian specified on HCM2000.

Table 4.16: P-LOS based on Average Pedestrian Space (Case-I)

Overpass		Slab/Deck				Stairway (Ascending)				Stairway (Descending)			
		Morning		Afternoon		Morning		Afternoon		Morning		Afternoon	
		Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak
Nyala Motors (OP-1)	A_P	6.9	34.6	9.3	33.0	6.3	31.4	8.5	29.9	6.4	32.1	8.6	30.5
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Hayat Hospital (OP-2)	A_P	26.5	66.4	28.1	58.4	24.1	60.2	25.5	53.0	24.6	61.5	26.0	54.1
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Bole Mikael (OP-3)	A_P	6.4	14.4	4.8	16.2	5.8	13.1	4.3	14.7	5.9	13.3	4.4	15.0
	PLOS	A	A	B	A	A	A	A	A	A	A	A	A
	A_P	9.5	22.9	6.0	19.2	8.6	20.8	5.5	17.5	8.8	21.3	5.6	17.8

St Yoseph (OP-4)	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Addisu Sefer (OP-5)	A_P	14.1	22.7	15.5	35.3	12.8	20.6	14.1	32.0	13.1	21.0	14.4	32.7
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Ersha Sebil (OP-6)	A_P	14.0	68.5	17.8	38.2	12.7	62.2	16.2	34.6	13.0	63.5	16.5	35.4
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Hana Mariam (OP-7)	A_P	41.2	279.8	40.6	215.2	37.3	253.9	36.8	195.3	38.1	259.3	37.6	199.4
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A

To see if the diversion of non-users within 200m range of distance had any effect on the LOS of the overpasses, PLOS was recalculated based on average pedestrian space after diversion of non-users (case-II) and presented in Table 4.17 below. The PLOS analysis was computed based on flow rate values from Table 4.12 and pedestrian speeds in Table 4.15. In the morning peak period, the average pedestrian space along Bole Mikael overpass (OP-3) is reduced to an average pedestrian space of 4.5m^2/p (from 4.8m^2/p in case-I) but with no change in the LOS which is still categorized as PLOS-B. The PLOS of the facilities computed by considering users only remained the same even after pedestrians within 200m range of distance are considered. The facilities, in general, provide adequate pedestrian space categorized as PLOS-A or B when user pedestrians and non-users within 200m range of distance are considered for the analysis (case-II). Therefore, pedestrian overpasses along the study route fulfill the requirement of basic area for standing pedestrian (0.3 m^2) and an area used to evaluate pedestrian facility (0.75m^2) as a buffer zone for each pedestrian specified on HCM2000. Even if the PLOS remained the same (for case-I and case-II analysis), the average pedestrian area (A_P) is relatively reduced in case-II analysis as a result of diversion of non-users within 200m to the overpass facilities.

Table 4.17: P-LOS Based on Average Pedestrian Space (Case-II)

Overpass		Slab/Deck				Stairway (Ascending)				Stairway (Descending)			
		Morning		Afternoon		Morning		Afternoon		Morning		Afternoon	
		Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak
Nyala Motors (OP-1)	A_P	6.4	31.4	7.8	27.9	5.8	28.5	7.1	25.3	5.9	29.1	7.2	25.9
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Hayat Hospital (OP-2)	A_P	25.6	60.8	26.1	56.2	23.2	55.2	23.7	51.0	23.7	56.4	24.2	52.0
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Bole Mikael (OP-3)	A_P	6.1	12.7	4.5	13.7	5.5	11.5	4.1	12.4	5.7	11.8	4.1	12.7
	PLOS	A	A	**B**	A	A	A	A	A	A	A	A	A
St. Yoseph (OP-4)	A_P	9.0	21.0	5.7	17.8	8.2	19.1	5.2	16.1	8.4	19.5	5.3	16.5
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Addisu Sefer (OP-5)	A_P	11.7	21.0	13.2	26.2	10.6	19.1	12.0	23.8	10.9	19.5	12.3	24.3
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A

Ersha Sebil (OP-6)	A_P	13.8	54.5	17.0	33.8	12.6	49.5	15.4	30.7	12.8	50.5	15.8	31.3
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Hana Mariam (OP-7)	A_P	34.1	254.4	37.3	155.5	31.0	230.8	33.9	141.1	31.6	235.7	34.6	144.0
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A

The last case of PLOS analysis (case-III), considers non-users up to half distance of next pedestrian facilities in both sides in addition to overpass users. The PLOS analysis was computed based on flow rate values from Table 4.14 and pedestrian speeds from Table 4.15. The results of PLOS in case-III reveal that the addition and diversion of non-user pedestrians up to half distance of next pedestrian facility can be accommodated and be served with a PLOS-A, PLOS-B or PLOS-C. The diversion had resulted in a reduction in average pedestrian space per pedestrian and change in the PLOS computed in the previous two cases. The average pedestrian space along the Bole Mikael overpass (OP-3) was 4.8m^2/p (PLOS-A) in case-I, 4.5 m^2/p (PLOS-B) in case-II and reduced to 3.5m^2/p (PLOS-C) in case-III in the afternoon peak periods on the slab/deck. As compared to the other overpasses, the P-LOS of Bole Mikael overpass (OP-3) is relatively poor characterized by sufficient space for normal walking speeds, for bypassing other pedestrians in primarily unidirectional streams. Reverse direction or crossing movements can cause minor conflicts, speeds and flow are lower.

Table 4.18: P-LOS Based on Average Pedestrian Space (Case-III)

Overpass		Slab/Deck				Stairway (Ascending)				Stairway (Descending)			
		Morning		Afternoon		Morning		Afternoon		Morning		Afternoon	
		Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak
Nyala Motors (OP-1)	A_P	4.4	19.5	3.7	14.2	4.0	17.7	3.4	12.9	4.1	18.1	3.5	13.1
	PLOS	B	A	B	A	A	A	A	A	A	A	A	A
Hayat Hospital (OP-2)	A_P	22.8	49.5	22.6	53.1	20.7	44.9	20.5	48.2	21.1	45.9	21.0	49.2
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Bole Mikael (OP-3)	A_P	4.5	8.1	3.5	8.8	4.1	7.4	3.2	8.0	4.2	7.5	3.2	8.2
	PLOS	B	A	C	A	A	A	A	A	A	A	A	A
St Yoseph (OP-4)	A_P	6.6	15.4	4.2	13.4	6.0	14.0	3.8	12.2	6.1	14.2	3.9	12.4
	PLOS	A	A	B	A	A	A	A	A	A	A	A	A
Addisu Sefer (OP-5)	A_P	8.3	18.5	9.2	18.0	7.5	16.7	8.3	16.3	7.7	17.1	8.5	16.7
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Ersha Sebil (OP-6)	A_P	11.0	38.2	13.5	26.7	10.0	34.6	12.2	24.2	10.2	35.4	12.5	24.8
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A
Hana Mariam(OP-7)	A_P	18.8	174.9	16.3	66.6	17.0	158.7	14.8	60.5	17.4	162.0	15.1	61.7
	PLOS	A	A	A	A	A	A	A	A	A	A	A	A

P-LOS Based on Volume to Capacity Ratio (V/C)

The volume to capacity ratio (V/C) of the overpasses along the study route was computed by dividing the flow rate values by 75ped/min/m and 49ped/min/m for the deck/slab and stairway respectively as per the HCM2000.

Sample calculation of volume to capacity ratio (V/C) for Nyala Motors overpass (OP-1) in the morning peak period (case-I) is computed as follows.

- Flow rate in the morning peak = 10.59ped/min/m (without approximation, from Table 4.10)
- Capacity of pedestrian overpass (slab/deck) = 75ped/min/m (from HCM2000)
- Capacity of pedestrian overpass (stairway) = 49ped/min/m (from HCM2000)

$$\text{V/C (slab/deck)} = \left(\frac{\text{Flow rate}}{\text{Capacity}}\right) = \left(\frac{10.59\,\text{ped/min/m}}{75\,\text{ped/min/m}}\right) = 0.14, \text{ (PLOS category A)}$$

$$\text{V/C (stairway)} = \left(\frac{\text{Flow rate}}{\text{Capacity}}\right) = \left(\frac{10.59\,\text{ped/min/m}}{49\,\text{ped/min/m}}\right) = 0.22, \text{ (PLOS category A)}$$

The V/C ratio of all the overpasses fall to PLOS-A (Case-I). The pedestrian crossing demand at OP-3 is higher as compared to the other pedestrian overpasses along the study route which resulted in the highest V/C ratio. As far as the PLOS of the overpasses along the study route is categorized as ‘A’, the capacity of the overpasses is more than sufficient to serve user pedestrians.

Table 4.19: PLOS Based on Volume to Capacity (V/C) Ratios (Case-I)

Overpass	V/C and P-LOS	Slab/Deck				Stairway			
		Morning		Afternoon		Morning		Afternoon	
		Peak	Off Peak	Peak	Off Peak	Peak	Off Peak	Peak	Off Peak
Nyala Motors (OP-1)	V/C	0.14	0.03	0.10	0.03	0.22	0.04	0.16	0.05
	P-LOS	A	A	A	A	A	A	A	A
Hayat Hospital (OP-2)	V/C	0.04	0.02	0.04	0.02	0.06	0.02	0.06	0.03
	P-LOS	A	A	A	A	A	A	A	A
Bole Mikael (OP-3)	V/C	0.14	0.06	0.19	0.06	0.22	0.10	0.29	0.09
	P-LOS	A	A	A	A	A	A	A	A
St Yoseph Church (OP-4)	V/C	0.10	0.04	0.16	0.05	0.16	0.07	0.25	0.08
	P-LOS	A	A	A	A	A	A	A	A
Saris Addisu Sefer (OP-5)	V/C	0.07	0.04	0.07	0.03	0.11	0.07	0.10	0.04
	P-LOS	A	A	A	A	A	A	A	A
Ersha Sebil (OP-6)	V/C	0.07	0.01	0.05	0.02	0.10	0.02	0.08	0.04
	P-LOS	A	A	A	A	A	A	A	A
Hana Mariam (OP-7)	V/C	0.02	0.004	0.02	0.005	0.04	0.01	0.04	0.01
	P-LOS	A	A	A	A	A	A	A	A

The V/C ratio of the pedestrian overpasses was also computed by considering non-user pedestrians within 200m range of distance in addition to those who used the facilities to cross the Ring Road (case-II). Diversion has not brought any change to the LOS of the facilities except that an increase in the V/C ratio.

This implies that the capacity of the overpasses is good enough to serve non-users (after diverted to the facility) as the increase in V/C ratio has not brought change in PLOS computed in case-I.

Table 4.20: PLOS Based on Volume to Capacity (V/C) Ratios (Case-II)

Overpass	V/C and P-LOS	Slab/Deck				Stairway			
		Morning		Afternoon		Morning		Afternoon	
		Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Nyala Motors (OP-1)	V/C	0.15	0.03	0.12	0.03	0.23	0.05	0.19	0.05
	P-LOS	A	A	A	A	A	A	A	A
Hayat Hospital (OP-2)	V/C	0.04	0.02	0.04	0.02	0.06	0.03	0.06	0.03
	P-LOS	A	A	A	A	A	A	A	A
Bole Mikael (OP-3)	V/C	0.15	0.07	0.20	0.07	0.23	0.11	0.31	0.10
	P-LOS	A	A	A	A	A	A	A	A
St Yoseph Church (OP-4)	V/C	0.11	0.05	0.17	0.06	0.17	0.07	0.26	0.08
	P-LOS	A	A	A	A	A	A	A	A
Saris Addisu Sefer (OP-5)	V/C	0.09	0.05	0.08	0.04	0.13	0.07	0.12	0.06
	P-LOS	A	A	A	A	A	A	A	A
Ersha Sebil (OP-6)	V/C	0.07	0.02	0.06	0.03	0.11	0.03	0.09	0.04
	P-LOS	A	A	A	A	A	A	A	A
Hana Mariam (OP-7)	V/C	0.03	0.004	0.03	0.01	0.04	0.01	0.04	0.01
	P-LOS	A	A	A	A	A	A	A	A

Non-users within up to half distance of the next facilities from the overpass were also considered to compute the V/C ratio and the corresponding P-LOS (case-III). This consideration had increased the V/C ratio and has altered the PLOS computed in the Case-I&II. For instance, the V/C ratio of slab/deck of the Nyala Motors (OP-1) was 0.14 (PLOS-A) and 0.15 (PLOS-A) in case-I and case-II respectively but increased to 0.22 (PLOS-B) in analysis case-III. In addition, the LOS of stairways of Nyala Motors (OP-1), Bole Mikael (OP-3) and St. Yosef (OP-4) had changed to 'B' in case-III analysis (in the afternoon). The results imply that the capacity of the overpasses is good enough to serve all non-users (if diverted to the facility and utilized 100%) in addition to facility-user pedestrians.

Table 4.21: PLOS Based on Volume to Capacity (V/C) Ratios (Case-III)

Overpass	V/C and P-LOS	Slab/Deck				Stairway			
		Morning		Afternoon		Morning		Afternoon	
		Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Nyala Motors (OP-1)	V/C	0.22	0.05	0.26	0.07	0.34	0.08	0.40	0.11
	P-LOS	B	A	B	A	B	A	B	A
Hayat Hospital (OP-2)	V/C	0.05	0.02	0.05	0.02	0.07	0.03	0.07	0.03
	P-LOS	A	A	A	A	A	A	A	A
Bole Mikael (OP-3)	V/C	0.20	0.11	0.26	0.10	0.31	0.17	0.40	0.16
	P-LOS	A	A	B	A	A	A	B	A
St. Yoseph (OP-4)	V/C	0.15	0.06	0.24	0.07	0.23	0.10	0.36	0.11
	P-LOS	A	A	B	A	A	A	B	A
Saris Addisu Sefer (OP-5)	V/C	0.12	0.06	0.11	0.06	0.19	0.08	0.17	0.09
	P-LOS	A	A	A	A	A	A	A	A

Ersha Sebil (OP-6)	V/C	0.09	0.02	0.07	0.04	0.13	0.04	0.11	0.05
	P-LOS	A	A	A	A	A	A	A	A
Hana Mariam (OP-7)	V/C	0.05	0.01	0.06	0.01	0.08	0.01	0.09	0.02
	P-LOS	A	A	A	A	A	A	A	A

Three parameters which includes flow rate (V_P), pedestrian space (A_P) and volume to capacity (V/C) ratios were considered to classify the P-LOS of the overpass facilities along the study route. The result shows that the facilities can accommodate users and non-users with a PLOS-A, B or C.

4.2.2 Measure of Convenience (R)

The convenience measure (R) of each overpass was computed by considering the distance to be crossed while using the two alternatives (at-grade vs overpass).

$$\text{Measure of Convenience(R)} = \frac{\text{Time took or distance while using the overpass}}{\text{Time took or distance while crossing at grade level}} \text{ - - - - - - - } \mathbf{(4.4)}$$

Sample recorded crossing times in the field at each overpass is attached in the appendix (Table A.5 & Table A.6)

Sample calculation of measure of convenience (R) for the overpass at Saris Addisu Sefer (OP-5).

$$\text{Average time to cross using the overpass} = \frac{(P_{1u} + P_{2u} + \ldots + P_{40u})}{40} \text{ - - - - - - - - - - - - - - - } \mathbf{(4.5)}$$

$$\text{Average time to cross without overpass (at grade)} = \frac{(P_{1w} + P_{2w} + \ldots + P_{40w})}{40} \text{ - - - - - - - } \mathbf{(4.6)}$$

Where, P_{iu} and P_{iw} – Time took by i^{th} pedestrians to cross the road with and without the overpass respectively.

$$\text{Average time to cross using overpass} = \frac{(95+105+\ldots+98)}{40} = 111.08 \text{ Seconds}$$

$$\text{Average time to cross without the overpass (at grade)} = \frac{(92+31+\ldots+62)}{40} = 53.18 \text{ Seconds}$$

Hence, the average crossing time using Saris Addisu Sefer overpass (OP-5) is 111.08 seconds and 53.18 seconds without the facility. Therefore, R is computed by dividing the average time to cross using the overpass by the average time to cross without overpass.

$$R = \frac{\text{Average crossing time using Saris Addisu Sefder overpass (OP-5)}}{\text{Average crossing time without using the overpass within 200m range}} = \frac{111.08\text{Sec}}{53.18 \text{ Sec}} = 2.09$$

The measure of convenience of Saris Addisu Sefer overpass (OP-5) is 2.09 which implies that the facility takes more than twice of the time than the alternative at grade crossing takes. The measure of convenience (R) shows that the overpass facilities along the Addis Ababa Ring Road take more than twice of the time required to cross at grade level; hence characterized by their in-convenience.

Table 4.22: The Measure of Convenience of Pedestrian Overpasses along the Ring Road in Addis Ababa

Pedestrian Overpass	Measure of Convenience (R)
Nyala Motors(OP-1)	2.21
Hayat Hospital(OP-2)	2.01
Bole Mikael(OP-3)	2.08
St. Yoseph Church(OP-4)	1.61
Saris Addisu Sefer(OP-5)	2.09
Ersha Sebil(OP-6)	1.96
Hana Mariam(OP-7)	2.41

The average minimum time spent to cross the Road using the overpass is higher than the average maximum crossing time at street level. Thus, it is understandable that pedestrians reported time saving as a predominant factor that leads them to cross illegally. Pedestrians were also asked to rate the time they perceive will save if they crossed the Ring Road without the overpasses. Out of the 1063 pedestrians, 11% (119) perceive that at grade crossing does not save time at all, 37% (393) perceive that at grade crossing saves up to 25% of the time that the overpasses takes, 22%(230) perceive it saves 25-50%, 13%(143) perceive it saves 50-75% time and 17%(178) perceive that at grade crossing saves more than 75% of the time that the overpass takes.

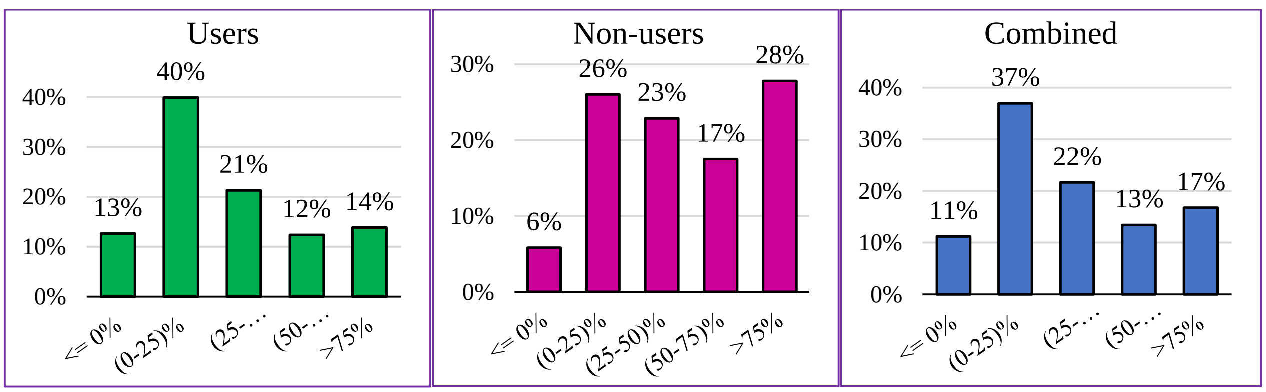


Figure 4.9: Perception of Time Saving if Pedestrians Avoid to Use Overpasses (General)

4.3 Location Appropriateness, Spacing, Accessibility, Capacity and Design of Overpasses

Different literatures were extensively reviewed to see requirements of a standard and inclusive design of overpass. Questionnaire was designed properly for pedestrians to rate the appropriateness of the current locations of the facilities, spacing (distance) between the overpasses and the next alternative crossing facility, design issues to meet their needs, accessibility, capacity and recommend measures to increase the utilization and performance.

4.3.1 Assessment of Location Appropriateness of Overpasses

Pedestrian overpass serves best if its provision is under consideration of the existence of pedestrians generating and attracting areas such as schools, market places, religious centers, transport stations and health centers. For the purpose of evaluating the location appropriateness, pedestrians were asked to rate the facilities based on different conditions. The following two questions were forwarded for participants at each location.

1. "How do you rate the location appropriateness of the overpass for the purpose of your trip that you are currently making?" Pedestrians were requested to rate the locations of each overpass as 'Excellent', Good', Satisfactory', 'Poor' and 'Very Poor'.
2. "How do you rate the accessibility of the overpass (are popular destinations such as schools, markets, health and religious centers within easy walking distance)?"

Pedestrians were asked to rate location appropriateness of each overpass based on its proximity to schools, market places, health centers, religious centers and ease of accessibility within short distance from highly populated areas and access road leading to the main road. Pedestrians were asked to rate each overpass facilities as 'Excellent', Good', Satisfactory', 'Poor', 'Very Poor' and 'Inaccessible'. They were also requested to recommend location preferences (if not satisfied with current location or from their day to day observations where there is a high volume of illegal crossing due to absence of alternative facility or any other reason). The analysis result in the next portion is presented case by case for each overpass facility.

Nyala Motors/ Anbessa Garage/ Overpass (OP-1)

Nyala Motors (OP-1) is located between *Megenanga* and *Imperia Junction* (formerly called *Bob-Marley* square). It is located at 1.5km from *Megenagna* and 0.7km before *Imperial* junction. It mainly serves pedestrians travelling to and from *Gerji to Haya Arat*.

Figure 4.10 (A&B): Location of Nyala Motors (Anbessa Garage) overpass (OP-1)

The number of survey participants to rate the location appropriateness of Nyala Motors (OP-1) both with respect to their trip purpose and its ease of accessibility to schools, markets, religious centers, transport terminals and health centers are 153 (112 users and 41 non-users). The analysis result shows that the locations of the overpass is in compliance with most pedestrian's trip purposes. Respondents rated its location as 'Excellent' (43%), 'Good' (26%), 'Satisfactory' (20%), 'Poor' (6%) and 'Very poor' (5%). Based on its accessibility and proximity to schools, markets, health and religious centers, 11 % rated as 'Excellent', 19% as 'Good', 27% as 'Satisfactory', 23% as 'Poor', 10% as 'Very Poor' and 12% as 'Inaccessible'. Most pedestrians suggested that an additional crossing facility shall be provided at *Egziabherab Junction* (in front of AMCE) where illegal crossing activity is a common scenario.

Hayat Hospital Overpass (OP-2)

This facility is located between *Imperia Junction* (formerly called *Bob-Marley* square) and Bole International Airport. It is at 0.95km from *Imperia Junction* and 0.5km before *Bole International Airport*. It is provided where one side of the road is a bare land where there is no settlement and does not attract or generate pedestrians.

Figure 4.11: Location of Hayat Hospital Overpass (OP-2)

The number of survey participants to rate the location appropriateness of the Hayat Hospital overpass (OP-2) were 128 (112 users and 16 non-users). The location of this overpass is in compliance with most pedestrian's trip purposes as obtained from the survey analysis. Pedestrians rated its current location as 'Excellent' (44%), 'Good' (30%), 'Satisfactory' (20%), 'Poor' (4%) and 'Very poor' (2%). Based on its accessibility and proximity to schools, markets, health and religious centers, 20% rated as 'Excellent', 21% as 'Good', 23% as 'Satisfactory', 16% as 'Poor', 9% as 'Very Poor' and 11% as 'Inaccessible'.

In general, the location of the Hayat Hospital overpass (OP-2) agrees with the principle that grade separated crossing facilities should ideally be on the ***normal*** path of pedestrian movements. This facility is located near a junction (the only major junction with high volume of pedestrians between Imperial and Bole) where a road with high pedestrian flow joins the Ring Road. A health center (Hayat Hospital) just in front of the facility that makes its location more justifiable as compared to other land uses between *Imperial* and *Bole*.

Bole Mikael Overpass (OP-3)

Bole Mikael Overpass (OP-3) is located in front of St. Mikael Church between *Bole Mikael Junction* (formerly roundabout & currently operating with traffic light) and St. Yosef Overpass (OP-4). It is located at about 0.3km from *Bole Mikael Junction* and 2.0km before *St. Yosef Overpass (OP-4).*

Figure 4.12: Location of Bole Mikael Overpass (OP-3)

A total of 150 pedestrians (126 users and 24 non-users) were surveyed to rate the location appropriateness of Bole Mikael Overpass (OP-3). The respondents rated the location as ‘Excellent’ (38%), ‘Good’ (34%), ‘Satisfactory’ (18%), ‘Poor’ (7%) and ‘Very Poor’ (3%). At this area, a large volume of pedestrian flow exists throughout the day. The location of OP-3 agrees with the principle that overpass should be located where large volume of pedestrians exist. Based on its accessibility and proximity to schools, markets, health and religious centers, 19% rated as ‘Excellent’, 23% as ‘Good’, 21% as ‘Satisfactory’, 16% as ‘Poor’, 13% as ‘Very Poor’ and 8% as ‘Inaccessible’. Respondents at this location suggest that a pedestrian facility shall be provided at *Mammo* and *Bole Airpor*t *Cargo Terminal* where extremely large volume of pedestrians are left with no option to cross the Ring Road other than jumping over barriers or travel long distance in search for another crossing alternatives. The entry to Bole Airport Cargo terminal, which is not only nationally but also internationally important area, has no pedestrian facility.

St. Yosef Overpass (OP-4)

St. Yosef overpass (OP-4) is located in front of St. Yosef Church between *Bole Mikael (OP-3)* and *Kadisco Square*. It is located at about 2.0km from *Bole Mikael Overpass (OP-3)* and 0.73km before *Kadisco Square*.

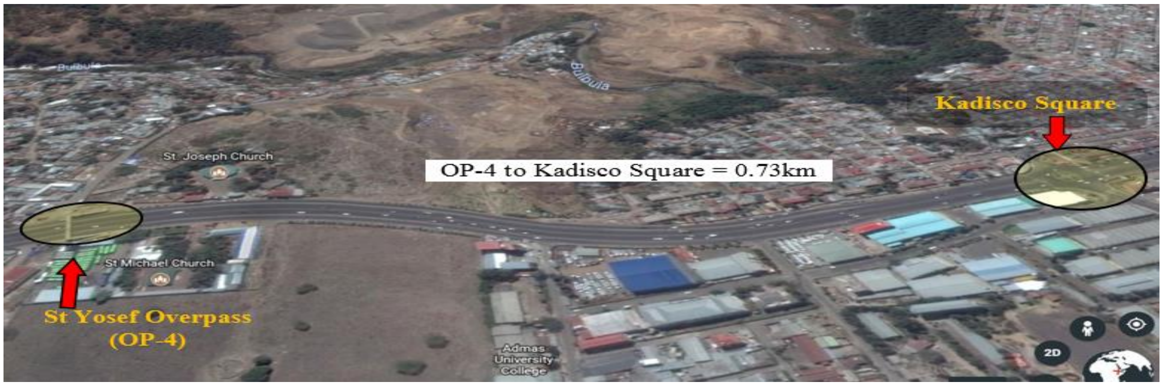


Figure 4.13: Location of St. Yosef Overpass (OP-4)

A total of 160 pedestrians (123 users and 37 non-users) were surveyed to rate the location appropriateness of St. Yosef Overpass (OP-4). The respondents rated the location of the facility as ‘Excellent’ (29%), ‘Good’ (24%), ‘Satisfactory’ (19%), ‘Poor’ (15%) and ‘Very poor’ (13%). Based on its accessibility and proximity to schools, markets, health and religious centers, 20% rated as ‘Excellent’, 19% as ‘Good’, 23% as ‘Satisfactory’, 18% as ‘Poor’, 11% as ‘Very Poor’ and 9% as ‘Inaccessible’. Pedestrians have suggested a facility to be provided at *Mammo* where large volume of pedestrians especially students from *Agaziyan*, *Sibiste* and *Nifas Silk* schools cross the Ring Road in a risky way. *Mammo* is at about 340m before St. Yosef overpass (OP-4) where large volume of illegal crossing exists and residents and students do not have options other than jumping over barriers or travelling additional 340m (totally 680m), which is not acceptable distance by most of them.

Saris Addisu Sefer Overpass (OP-5)

Saris Addisu Sefer Overpass (OP-5) is located between *Kadisco* square and *Ersha Sebil Overpass (OP-6).* It is located at about 0.376km from *Kadisco* square and 1.026km before *Ersha Sebil Overpass (OP-6).* This facility is located at a densely populated area where a large volume of pedestrian movement exists.

Figure 4.14: Location of Saris Addisu Sefer Overpass (OP-5)

A total of 153 pedestrians (124 users and 29 non-users) were surveyed to rate the location appropriateness of Saris Addisu Sefer Overpass (OP-5) for the purpose of the trip they are making. The respondents rated its location as ‘Excellent’ (44%), ‘Good’ (26%), ‘Satisfactory’ (21%), ‘Poor’ (5%) and ‘Very poor’ (4%). Based on its current location for accessibility and proximity to schools, markets, health and religious centers, 16% rated as ‘Excellent’, 17% as ‘Good’, 24% as ‘Satisfactory’, 26% as ‘Poor’, 10% as ‘Very

Poor' and 7% as 'Inaccessible'. Participants at this area have suggested that at the entry to *Zenbaba* Hospital, a pedestrian facility is necessary.

Ersha Sebil Overpass (OP-6)

This facility is located between *Saris Addisu Sefer* overpass (OP-5) and *Abo square*. It is located at about 1.026km from *Saris Addis Sefer Overpass (OP-5)* and 0.69km before *Saris Abo Square.*

Figure 4.15 (A): Location of Ersha Sebil Overpass (OP-6)

A total of 163 pedestrians (125 users and 38 non-users) were surveyed to rate the location appropriateness of *Saris Addisu Sefer* overpass (OP-5). The respondents rated the current location of the facility as 'Excellent' (28%), 'Good' (23%), 'Satisfactory' (24%), 'Poor' (15%) and 'Very Poor' (10%). Based on its current location for accessibility and proximity to schools, markets, health and religious centers, 7% rated as 'Excellent', 17% as 'Good', 28% as 'Satisfactory', 17% as 'Poor', 9% as 'Very Poor' and 22% as 'Inaccessible'.

The Ersha Sebil overpass (OP-6) misses the path of the majority of pedestrians travelling to and from *Saris Gulit* (local marketplace) and *Bulbula School* which generates and attracts a high volume of pedestrians. Its location misses the path of students and residents travelling to and from *Bulbula School* and a local marketplace called *Saris Gulit*. Large volume of pedestrians cross the road without the facility at a distance of 212m (totally 424m). It is located where there is no access road to the and is away from the access road to the school and market place as a result pedestrians cross over barriers than wasting time while travelling additional distance of 424m laterally to the facility. Access road to the facility is possible only from one side as the fence of Ersha Sebil compound exists on one side of the road.

A comparison of volume of users to volume of no-users at Day-1 count had been made. The result shows that an 8-hour volume of non-user pedestrians accounts to 4,801 pedestrians who avoid Ersha Sebil overpass (OP-6). The same 8-hour count (Day-1) of user pedestrians accounts to 2,402 pedestrians. In average, 151 pedestrians cross the illegally every 15-minutes whereas only 79 pedestrians cross using the overpass. The peak 15-minute volume of users and non-users (at 212m from the facility) are 213 to 172 respectively. Hence, from the survey response and comparison of volume at the two alternatives, the location of Ersha Sebil overpass is wrong/inappropriate. Therefore, a pedestrian crossing facility shall be provided to guarantee the safety of students and resident travelling to and from *Bulbula School* and *Saris Gulit* local market.

Figure 4.15 (B): Location of Ersha Sebil Overpass (OP-6)

Hana Mariam Overpass (OP-7)

Hana Mariam Overpass (OP-7) is located between *Kality Interchange* and *Hana Qelebet Interchange*. It is located at about 1.18km from *Kality Interchange* and 1.12km before *Hana Qelebet Interchange.* The facility is located where there is no access road joining the Ring Road in both sides where one side of the overpass terminates just in front of local residents property line and the other side just in front of small shops. Illegal crossing is observed in front of *Kadisco Asian Paints* located at 430m from the facility (on the road to Kality).

Figure 4.16: Location of Hana Mariam Overpass (OP-7)

A total of 156 pedestrians (118 users and 38 non-users) were surveyed to rate the location appropriateness of *Hana Mariam* pedestrian overpass (OP-7) for the purpose of the trip they are making. The respondents rated the current location of the facility as 'Excellent' (31%), 'Good' (35%), 'Satisfactory' (15%), 'Poor' (13%) and 'Very Poor' (6%). Based on its current location for accessibility and proximity to schools, markets, health and religious centers, 18% rated as 'Excellent', 21% as 'Good', 19% as 'Satisfactory', 13% as 'Poor', 8% as 'Very Poor' and 21% as 'Inaccessible'.

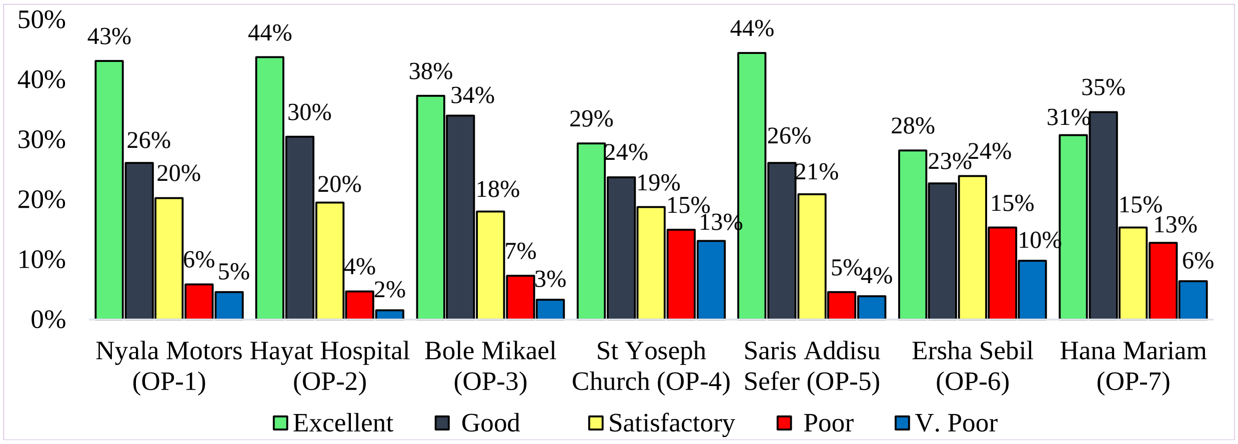


Figure 4.17: Location Appropriateness of Overpasses for Pedestrians Trip Purpose (Rated by Participants)

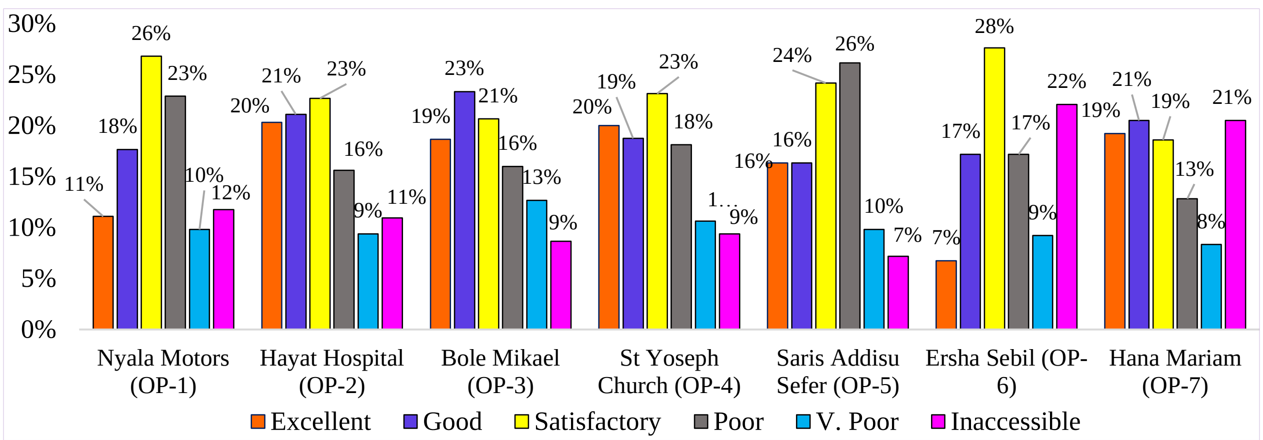


Figure 4.18: Location and Accessibility of Overpass to Schools, Markets, etc (Rated by Participants)

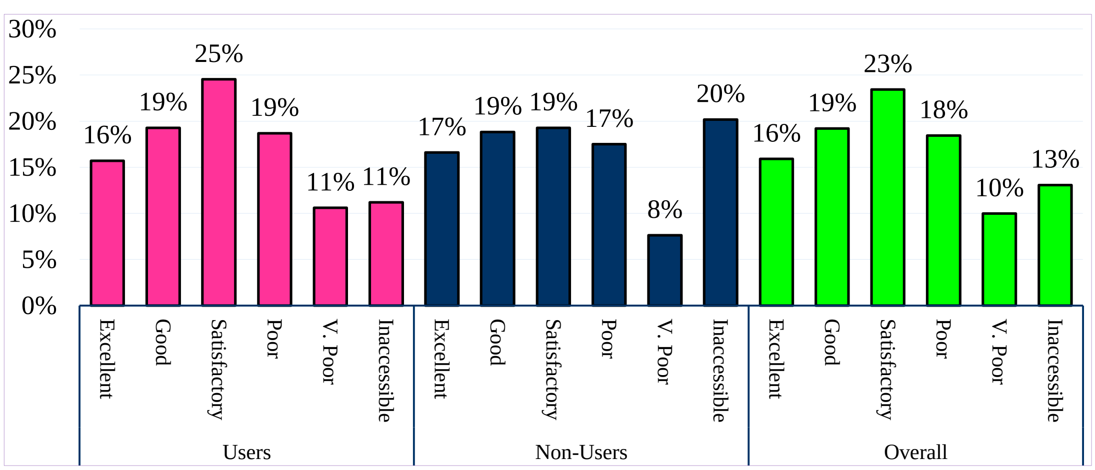


Figure 4.19: Location and Accessibility of Overpass to Schools, Markets, and Religious Centers etc (General)

4.3.2 Assessment of Capacity of Pedestrian Overpasses

In addition to the volume to capacity V/C ratio analysis, pedestrians were asked to rate the amount of congestion they feel as 'Very High', 'High', 'Moderate', 'Low' and 'Very Low', which indirectly indicates current capacities of the facilities from pedestrians experience. How pedestrians rated the congestion they feel indirectly expresses capacity as compared to the volume of pedestrians at each area. For the purpose of comparing the rate of congestion on the facilities, a score had been assigned in a way that same response weighs equal (i.e **5** for 'Very High', **4** for 'High', **3** for 'Moderate', **2** for 'Low' and **1** for 'Very Low').

Table 4.23: Responses and Assigned Weights to Rate the Congestions on the Overpasses

Pedestrian Overpasses	Pedestrian Category	Response Scales and Assigned Weights					Total
		Very High **(5)**	High **(4)**	Moderate **(3)**	Low **(2)**	Very Low **(1)**	
Nyala Motors (OP-1)	Users	8	10	45	31	18	112
	Non-Users	4	4	19	9	5	41
	Combined	12	14	64	40	23	153
Hayat Hospital (OP-2)	Users	14	13	38	27	20	112
	Non-Users	1	2	9	2	2	16
	Combined	15	15	47	29	22	128
Bole Mikael (OP-3)	Users	23	30	47	20	6	126
	Non-Users	5	7	10	2	0	24
	Combined	28	37	57	22	6	150
St Yoseph Church (OP-4)	Users	24	19	48	24	8	123
	Non-Users	6	10	14	4	3	37
	Combined	30	29	62	28	11	160
Saris Addisu Sefer (OP-5)	Users	13	24	65	19	3	124
	Non-Users	6	3	12	5	3	29
	Combined	19	27	77	24	6	153
Ersha Sebil (OP-6)	Users	6	7	50	37	25	125
	Non-Users	6	4	8	7	13	38
	Combined	12	11	58	44	38	163
Hana Mariam (OP-7)	Users	8	10	44	29	27	118
	Non-Users	6	2	9	4	17	38
	Combined	14	12	53	33	44	156
Total							1,063

Sample calculation of the weighted sum of responses for the Hayat Hospital overpass (OP-2) is computed as follows considering responses of both users and non-user pedestrians (combined).

Total number of Respondents = 128 (112 users and 16 non-users), Number of responses with 'Very High' = 15, 'High' = 15, 'Moderate' = 47, 'Low' = 29 and 'Very Low' = 22.

$$\text{Weighted Sum} = \frac{\text{Sum of the product of \# of particular response \& corresponding weight}}{\text{Total number of responses}} \quad \textbf{- - - - - - (4.7)}$$

$$\text{Weighted Sum} = \frac{(5*15)+(4*15)+(3*47)+(2*29)+(1*22)}{128} = 2.78$$

This value (2.78) ranks 4th when compared with the weighted sum of the rest pedestrian overpasses along the study route. Pedestrians experience the highest congestion along the Bole Mikael overpass (OP-3) as compared to other overpasses and it is ranked 1st based on weighted sum. This happens because of the land use surrounding the facility is characterized as pedestrian attracting/ generating area such as St. Mikael Church. The 2nd, 3rd, 4th and 5th ranks are held by St Yoseph (OP-4), Saris Addisu Sefer (OP-5), Hayat Hospital (OP-2) and Nyala Motors (OP-1) respectively. In the contrary, Hana Mariam and Ersha Sebil overpasses, which rank 6th and 7th, have the lowest congestion as compared to the other overpasses along the study route.

The smallest congestion exists on Ersha Sebil overpass (OP-6) because pedestrians travelling to and from *Saris Gulit* and *Bulbula School* almost totally abandon the facility and cross the road over barriers rather than travelling 212m (totally 424m) laterally to the facility. This facility is not located in line with most pedestrian's journey path and is criticized for its inappropriate location by the locals. There is a long property line (fence) of Ersha Sebil compound which makes the facility accessible from one side of the road only.

Table 4.24: Rank of Congestion on Overpasses Using Weighted Sum of Survey Responses (Overall)

Overpasses	Weighted Sum of Responses						Rank
	Very High	High	Moderate	Low	Very Low	Total Score	
Nyala Motors (OP-1)	0.39	0.37	1.25	0.52	0.15	2.69	**5th**
Hayat Hosp. (OP-2)	0.59	0.47	1.10	0.45	0.17	2.78	**4th**
Bole Mikael (OP-3)	0.93	0.99	1.14	0.29	0.04	3.39	**1st**
St Yoseph (OP-4)	0.94	0.73	1.16	0.35	0.07	3.24	**2nd**
Saris Addisu (OP-5)	0.62	0.71	1.51	0.31	0.04	3.19	**3rd**
Ersha Sebil (OP-6)	0.37	0.27	1.07	0.54	0.23	2.48	**7th**
Hana Mariam (OP-7)	0.45	0.31	1.02	0.42	0.28	2.48	**6th**

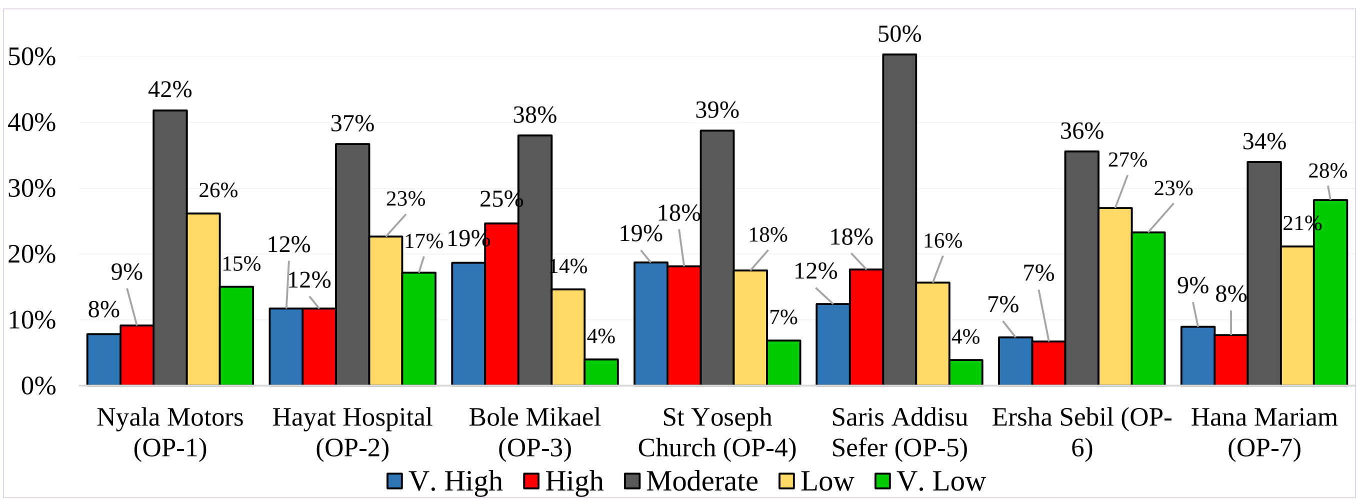


Figure 4.20: Rate of Congestion along the Overpasses from Pedestrians Experience (Combined)

The V/C ratios computed by considering pedestrians in all the three cases resulted in a value less than 1.0 (see P- LOS analysis based on V/C ratio sections). Therefore, the overpass facilities along the study route serve well below their design capacities (75ped/min/m and 49ped/min/m for the slab/deck and the stairway).

4.3.3 Spacing of Pedestrian Overpasses along the Ring Road

The study route is about 14km long and has a total of 12 pedestrian crossing facilities which are supposed to be legal to use. The average spacing of crossing facilities along the road is greater than 1.0km although not uniform throughout the route. For instance, the spacing between Bole Mikael overpass (OP-3) and St. Yosef overpass (OP-4) is 2.0km whereas between Bole Mikael junction and Bole Mikael overpass (OP-3) is about 300m only.

Figure 4.21: Distance (spacing) between Bole Mikael (OP-3) and St. Yosef Overpasses (OP-4) is 2km.

In literature review portion, the commonly accepted walking distances and pedestrian overpass facility spacing guides and common practices were elaborated. As a very long spacing would result to disregarding overpasses by pedestrians, they shall be kept within acceptable walking distances to the farthest pedestrian. As stated by WHO (2013), in addition to convenience, safety and security, the level of use of pedestrian overpass depends on walking distances compared with alternative crossing locations.

Table 4.25: Guidelines and Provisions of Spacing and Acceptable Walking Distance

Guidelines and Provisions	Source
Two or more crosswalk facilities shall not be placed within 200m distance of each other.	Jaisung C. et al. (2013)
Lots of pedestrians will not walk more than 200ft (61m) laterally in order to cross a street and pedestrians are likely to seek out other crossing opportunities when crosswalks or intersections spacing exceeds 400ft (122m).	Francis G. (2016)

In the Guidelines for Acceptable Walking Distance, it is suggested that street crossing facilities are typically most effective when located approximately 120 to 180m apart in areas heavily used by pedestrians.	Otak (1997)
A pedestrian overpass shall not be constructed or provided if a reasonable at-grade crossing is available within 180meters.	Ottawa DOT (2009)
Pedestrians will generally not travel further than 600ft (183m) to use a pedestrian overpass if an alternate, but less safe, at-grade crossing is available.	BFA (1998)
A survey of residents travel in Tianjin, China, displayed that most of pedestrian walking distance is within a range of 400-500m. The research found that 100% of the people are willing to accept a walking distance of 100m, 69.4% of people accepted 150m, 54.4% of the people can accept 200m, and 27.5% of people can accept more than 200m.	Juan L. et al. (2013)
Footbridges should be located at 1.5km depending on land use and population.	MSI (2010)
In public transport studies, public transport ***accessibility*** is associated with a certain number that is related to walking distance or walking time. Most public transport studies assume that walking as an access mode occurred up to 400 to 800 meters of walking distance or 10 to 15 minutes of walking time. Inaccessibility or poor accessibility of public transport means that the distance or time to walk to access public transport terminal is longer than these numbers.	Sony S. & Piotr O. (2005)

Transportation planners generally use about 0.4km, approximately a 5-minute walk, as the acceptable walking distance to transit stops, beyond which another connecting mode is required. It was intended to show whether the spacing between the facilities is within acceptable walking distance by comparing against the maximum limit of 400m (conservative approach) as comparing it with the minimum limit has no significant implication. According to Ann Frye (2013), the recommended maximum walking distances are particularly limited for those who walk with aid such as a stick, walking aid and wheelchairs.

Table 4.26: Recommended Maximum Walking Distance Without Rest for Different Types of Impairment

Type of impairment	Recommended Maximum Walking Distance Without Rest
Wheelchair user	150m
Mobility impaired person using stick	50m
Mobility impaired person without walking aid	100m

Source: UK Department for Transport (2002) cited in Ann Frye (2013)

Then based on the review, a distance of 400m or a spacing of 800m was set as criteria or limit in order to label the walking distances and spacing between facilities along the Ring Road as ‘Acceptable’ or ‘Not Acceptable’.

Table 4.27: Spacing (Distance) Between Pedestrian Facilities and Walking Distances along the Study Route

From	To	Spacing (m)	Spacing Category	Half Distance (Maximum distance to the furthest pedestrian)	Walking Distance Category
Megenagna	Nyala Motors (OP-1)	1500	Not Acceptable	750	Not Acceptable
Nyala Motors (OP-1)	Imperial (Bob Marley) Square	700	Acceptable	350	Acceptable
Imperial (Bob Marley) Square	Hayat Hospital Overpass (OP-2)	950	Not Acceptable	475	Not Acceptable
Hayat Hospital Overpass(OP2)	Bole Intl Airport	500	Acceptable	250	Acceptable
Bole Mikael (Traffic light)	Bole Mikael Overpass (OP-3)	304	Acceptable	152	Acceptable
Bole Mikael Overpass (OP-3)	St. Yoseph Overpass(OP-4)	2000	Not Acceptable	1000	Not Acceptable
St. Yoseph Overpass(OP-4)	Kadisco Square	730	Acceptable	365	Acceptable
Kadisco Square	Saris Addisu Sefer (OP-5)	376	Acceptable	188	Acceptable
Saris Addisu Sefer (OP-5)	Ersha Sebil Overpass (OP-6)	1026	Not Acceptable	513	Not Acceptable
Ersha Sebil Overpass (OP-6)	Abo Square	690	Acceptable	345	Acceptable
Kality Interchange	Hana Mariam Overpass (OP-7)	1180	Not Acceptable	590	Not Acceptable
Hana Mariam Overpass (OP-7)	Hana Qelebet Bridge	1120	Not Acceptable	560	Not Acceptable

In conclusion, 50% of the walking distances and spacing between facilities along the study route are far beyond the acceptable walking distance limit. Some of the spacing between the facilities along the route are almost twice of the limit. For instance, between Bole Mikael (OP-3) and St. Yoseph (OP-4) is 2.0km which forces the furthest pedestrians to walk 1.0km which is greater than twice of the limit (400m). Between Megenagna and Nyala Motors (OP-1) is 1.5km; since pedestrians between these two facilities do not have option, they are forced to walk a distance of 750m to either of the two facilities or jump over barriers particularly at *Egziabherab Junction*. The spacing is even worse for disabled and elderly pedestrian.

Pedestrians were asked to rate the distance (spacing) between pedestrian overpass facilities or an overpass and next crossing treatment along the study route as ‘Very Large’, ‘Large’, ‘Adequate’, ‘Close’ and ‘Very Close’. From the respondents, 53% of users and 57% of non-users perceive that the spacing between pedestrian overpass facilities is ‘Very Large’. Furthermore, 23% of users and 24% of non-users as 'Large', 19% of users and 15% of non-users rated the spacing as 'Adequate' or Ideal, 4% of users and 4% of non-users as 'Close' and 2% of users and 1% of non-users as 'Very Close'. In general almost half of survey respondents perceive that the spacing is 'Very Large'.

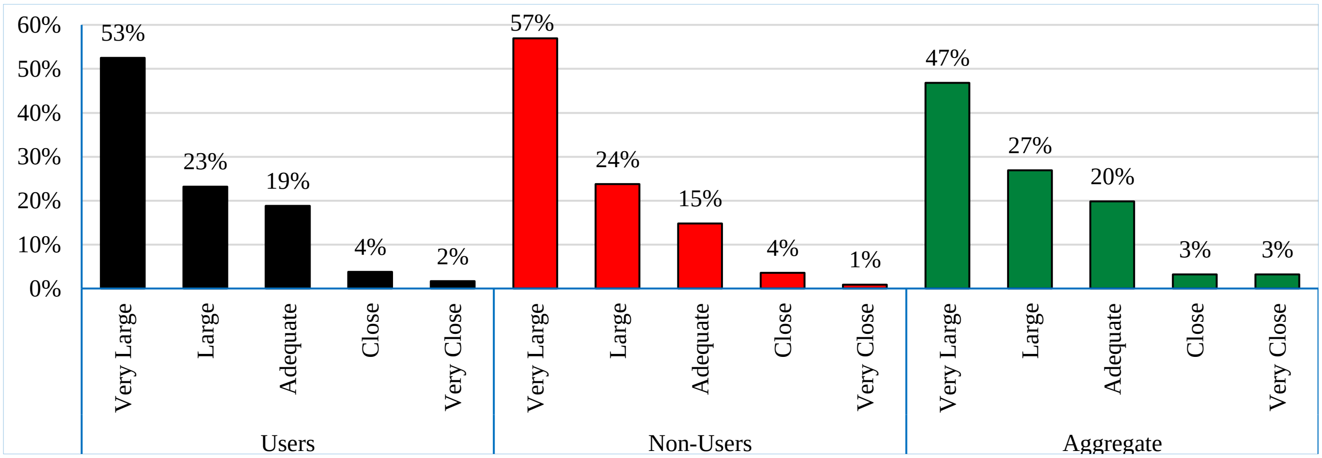


Figure 4.22: How Pedestrians Rated the Spacing (Distance) of Crossing Facilities along the Ring Road

The spacing being too far possibly forces pedestrians not to use overpasses as it puts extra effort and time to walk laterally in search for safe crossing facilities resulting in poor utilization of overpasses. Pedestrian were asked a ***YES/NO*** question whether the current spacing between the overpasses hinders them from using the facilities or not. The result shows that 63% of users and 69% of non-user pedestrians responded 'YES' i.e spacing affects or hinders pedestrians from using the facilities where as 27% of users and 24% of non-users responded 'NO', i.e the spacing is not the factor for not utilizing the facilities.

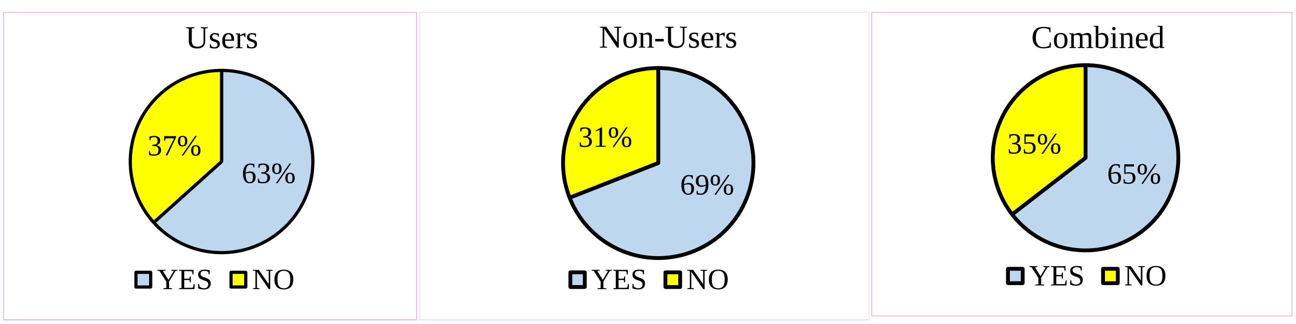


Figure 4.23: Pedestrians Response Weather Spacing Affect & Hinder Them from Using Overpasses

4.3.4 Accessibility and Design of Overpasses

Pedestrians were asked to rate the accessibility of the overpasses weather the facilities are within easy walking distance from popular origin/destinations such as schools, market areas, health centers and religious centers. Pedestrians were asked to rate the accessibility of each overpass facility as 'Excellent', Good', Satisfactory', 'Poor', 'Very Poor' and 'Inaccessible'. They were also requested to recommend places along the Ring Road where they observed high volume of illegal crossings due to absence of alternative facility or any other reason. Pedestrian count had been conducted at this areas for 8-hours for three weekdays. Table 4.34 below shows the ranks of overpasses based on their accessibility (based on easy walking distance from popular origin/destinations). The ranking is done based on weighted sum of responses of pedestrians by assigning a score (weight) of 5 for ‘Excellent’, 4 for ‘Good’, 3 for ‘Satisfactory’, 2 for ‘Poor’, 1 for ‘Very Poor’ and 0 for ‘Inaccessible’. Hayat Hospital overpass (OP-2), which ranked 1st, is the best accessible facility followed by Bole Mikael overpass (OP-3), St. Yoseph overpass (OP-4) and Saris Addisu Sefer (OP-5) overpass which ranked 2nd, 3rd and 4th respectively. Overpasses with poor accessibility are Hana Mariam (OP-7), Nyala Motors (OP-1) and Ersha Sebil overpass (OP-6) which ranked 5th, 6th and 7th.

Table 4.28: Rank of Overpasses Based On Ease of Accessibility (Walking Distance from Origin/Destinations)

Overpasses	Weighted Sum of Responses						Total Score	Rank
	Excellent	Good	Satisfactory	Poor	Very Poor	Inaccessible		
Nyala Motors (OP-1)	0.56	0.71	0.80	0.46	0.10	0.00	2.62	6th
Hayat Hospital (OP-2)	1.02	0.84	0.68	0.31	0.09	0.00	2.95	1st
Bole Mikael (OP-3)	0.93	0.93	0.62	0.32	0.13	0.00	2.93	2nd
St Yoseph Church (OP-4)	1.00	0.75	0.69	0.36	0.11	0.00	2.91	3rd
Saris Addisu Sefer (OP-5)	0.82	0.65	0.73	0.52	0.10	0.00	2.82	4th
Ersha Sebil (OP-6)	0.34	0.69	0.83	0.34	0.09	0.00	2.29	7th
Hana Mariam (OP-7)	0.96	0.82	0.56	0.26	0.08	0.00	2.68	5th

Pedestrians were asked to rate the design of the overpasses with respect to usability and accessibility for disabled and elderly pedestrians as ‘Excellent’, ‘Good’, ‘Satisfactory’, ‘Poor’, ‘Very Poor’ and ‘Inaccessible’. Out of 1063 respondents (824 users and 223 non-users), 44% of user 53% non-users rated the accessibility as ‘Inaccessible’. Overall, 46% (469) of survey respondents rated the accessibility of the overpasses as ‘Inaccessible, 12% (126) as ‘Very Poor’, 17 %(181) as ‘Poor’, 12 %(123) as ‘Satisfactory’, 8 %(81) as ‘Good’ and 6 %(59) as ‘Excellent’. The responses imply that the design of the overpass facilities are not accessible and do not fulfill the requirements of elderly and disabled pedestrians.

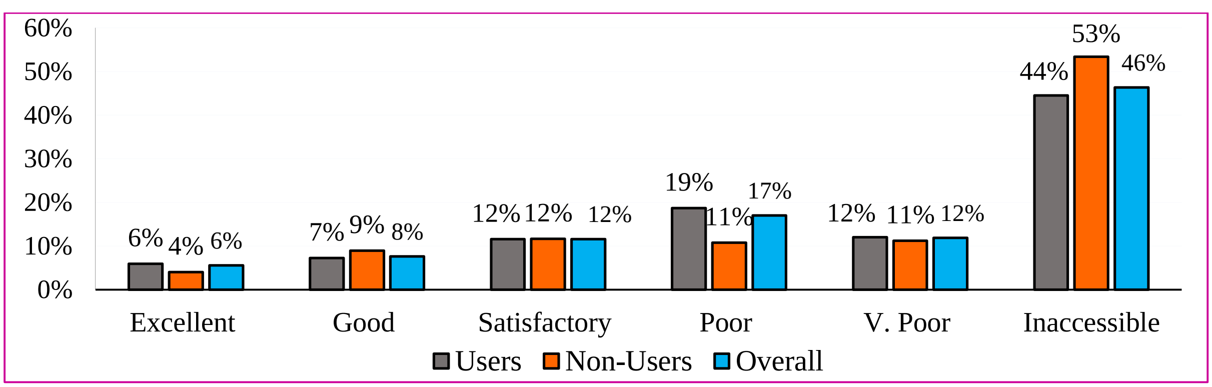


Figure 4.24: Accessibility and Usability of the Overpasses for Disabled and Elderly as rated by Pedestrians

4.4 Remedial Measures Suggested By Pedestrians

After an extensive review of literatures and field observations, problems that pedestrians face or create related to the Ring Road or the overpass facilities were identified. Then a questionnaire was designed and pedestrians were presented with possible remedial measures to select and thick on one or multiple alternatives and write any suggestions they think of to curb the problem. The suggested measures presented to the respondents include 11 options. Among the urgent and important measures suggested by pedestrians include awareness/information to pedestrians, additional provision of crossing facilities, improving accessibility for elderly and disabled pedestrians, reduce distance/spacing between facilities and punishment/enforcement are listed by decreasing order of importance. Aesthetic enhancement, increasing height of barriers/ fences to protect access to the road, removing illegal vendors and beggars are also suggested to reduce the problem but are not urgent. Relocation of overpasses, maintenance, relocation of schools and marketplaces are least preferable remedial measures suggested by user pedestrians as these are not the main cause of the problem.

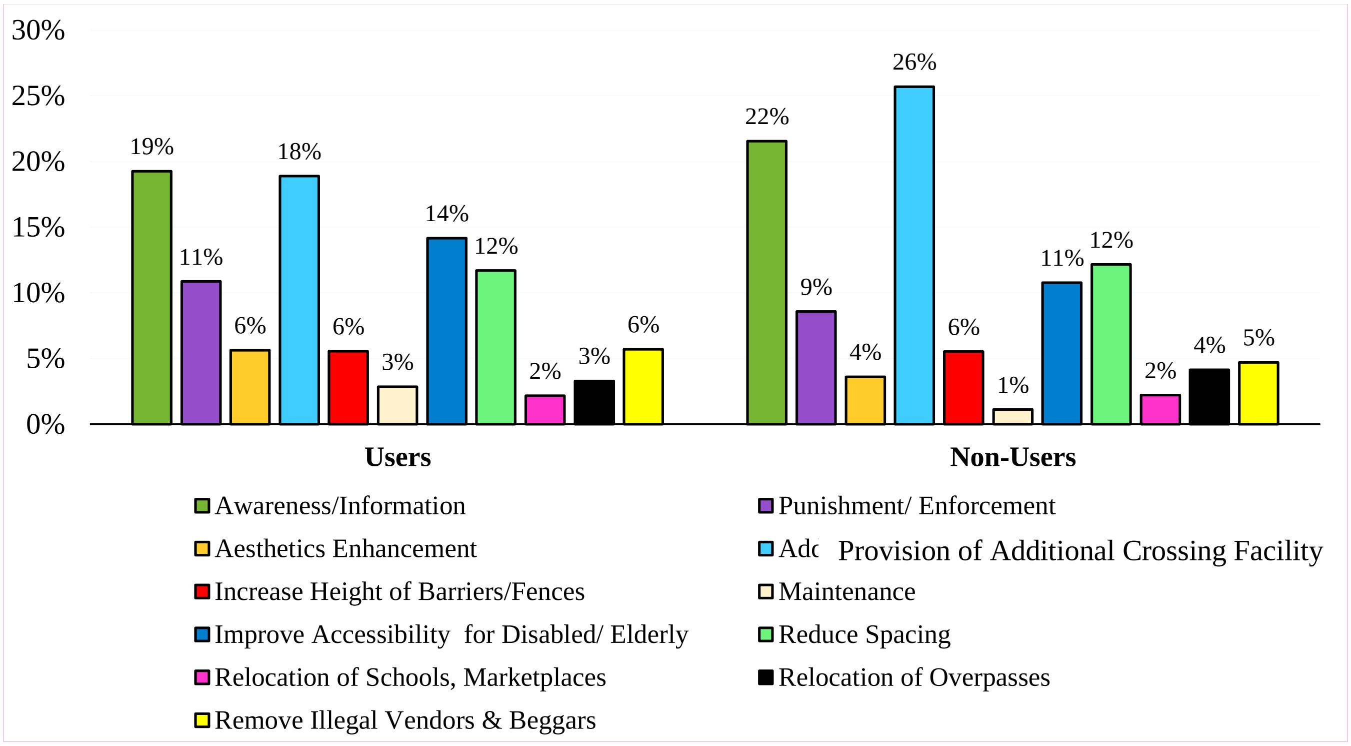


Figure 4.25: Measures to Curb Problems related to the Ring Road and Overpasses as Suggested by Pedestrians

Pedestrians were asked to suggest places, along the study route, where there is no alternative crossing treatment and as a result high volume of illegal crossing activities exist. In addition, a field observation had been made to identify places along the study route where the volume of illegal crossing is high due to absence of crossing facility. Table below presents places along the Ring Road where a large volume of pedestrians risk their life while crossing due to absence of pedestrian facility. The list is presented consecutively from Megenanga (where the study area starts) to Hana Mariam (where the study route terminates).

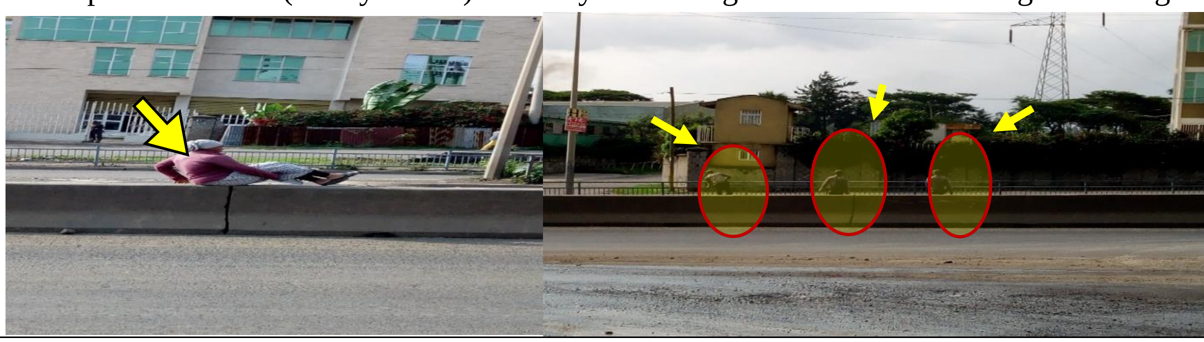
Table 4.29: Places along the Ring Road Where Pedestrians Cross Illegally Mainly Due To Absence of Pedestrian Facility

Local place names, descriptions of pedestrian attracting/ generating land uses & Pictures took During Site Visit
1. Egziabherab Junction: A local textile marketplace in front of AMCE attracts large volume pedestrians. Taxis, mini-buses and auto buses drop-off passengers before reaching Megenagna Transport Station as most of the time the approach gets congested. The nearest legal and safe crossing facility is at Megenagna which is one of the most congested places in Addis Ababa as it attracts and generates a large volume of pedestrians. 
2. Approach to Bole Dildiy: The New Taxi station at Bole attracts and generates pedestrians but pedestrians prefer to cross the Ring Road over fences to access the station.
3. Bole Airport Cargo Terminal: Bole International Airport Cargo Terminal entry where extremely large volume of pedestrians are left with no option to cross the Ring Road other than jumping over barriers or travel long distance in search for another crossing alternatives. The terminal, which is not only nationally but also internationally important area, has no pedestrian facility to cross the pedestrian access protected Ring Road.
4. Mammo: At *Mammo* where large volume of pedestrians especially students from *Agaziyan*, *Sibiste* and *Nifas Silk* schools cross the Ring Road in a risky way. *Mammo* is 340m before St. Yosef overpass (OP-4) where large volume of illegal crossing exists and residents and students do not have options other than jumping over barriers or travelling additional 340m (totally 680m), which is not acceptable by most of them
5. Adey Abeba/ Zenbaba Hospital: Just below the overhead road at Adey Abeba, taxis drop-off and pick passengers which makes pedestrians to jump over barriers.  

6. Approach to Abo Square: Abo church and the taxi and bus stations at this area attracts/generates a large volume of pedestrians. There is an alternative at grade crossing (Abo Square) within a very short distance and illegal crossing here is small.

7. Saris Gulit & Bulbula School: Pedestrians travelling to and from Saris Gulit (local marketplace) and Bulbula School almost totally abandon the nearby Ersha Sebil overpass (OP-6) and cross the road over barriers rather than travelling 212m (totally 424m) laterally to the facility. Illegal crossing here is greater than legal crossings by using the facility.

8. Kadisco (in front of Kadisco Asia Paints): The area is dominantly of industrial zone characterized by low volume of pedestrians. It is at 430m from the Hana Mariam (OP-7) and 750m from Kality interchange. Hence pedestrians from the access road cross here rather than travelling 430m (totally 860m) to Hana Mariam overpass OR 750m (totally 1.5km) to Kality Interchange which are the two legal crossing facilities.



9. China Teter: Insignificant volume of illegal crossing exists here relative to the other places (but it is significant as far as it is illegal with traffic rules perspective).

10. Approach to Hana Qelebet: Pedestrians here do have an option to cross using at grade at Hana Qelebet but few reluctant pedestrians avoid to use the legal means and cross just below the Interchange by Jumping over barriers. Insignificant volume of illegal crossing exists here relative to the other places (but it is significant as far as it is illegal with traffic rules perspective).

Four critical places out of the ten places along the study route where large volume of illegal crossing exists, were selected to check whether a warrant for a pedestrian overpass had been met or not. Warrants for a GSPC provision from different literatures were reviewed and checked against the existing conditions of these four places. The four places selected are *Bole Airport Cargo Terminal, Mammo, Saris Gulit or Bulbula School* and *Kadisco* (in front of *Kadisco Asia Paints*).

Table 4.30: Warrants for the Provision of GSPCs at Suggested Places by Pedestrians

	Considerations and Corresponding Warrants	Sources
Pedestrian volume	**#1.** Pedestrian volume > 300 during the highest continuous 4-hour period IF: Vehicle speed > 45 MPH, The proposed sites are in urban areas, AND The proposed site is neither over nor under a freeway. ELSE, pedestrian volume > 100 during the highest continuous 4-hour period. **#2.** Minimum average hourly pedestrian volume 150 and minimum average hourly volume of traffic of 600 during 8 hours of an average day. **#3.** ***On freeways***, the minimum of 100 pedestrians or bicyclists during any 4-hour period, 7,500 vehicles during the same 4-hour period, and an AADT of 25,000. ***On arterials***, the minimum of 300 pedestrians or bicyclists during any 4-hour period, 10,000 vehicles during the same 4- hour period, and an AADT of 35,000. **#4.** The existing or anticipated pedestrian crossing volume exceeds: 100 in 4-hours IF the crossing barrier is a freeway, river, canal, railroad, or other impedance. **#5.** Pedestrian volume should be a total of over 300 in the 4 highest continuous hour period if vehicle speed is over 40 mph and the proposed sites are in urban areas and not over or under a freeway. Otherwise, pedestrian volume should be a total of over 100 pedestrians in the 4 highest continuous hour period.	**#1.** Bowman et al. (1989) **#2.** Alaska DOT **#3.** Louisiana DOT **#4.** FPPD(1999) **#5.** Axler, 1984
Traffic speeds	**#1.** Minimum value of the 85th percentile of approaching vehicle speeds exceeds 60 km/hr, a minimum crossing width of 12 meters is exceeded	**#1.** Alaska DOT
Vehicular volumes	**#1.** Vehicle volume > 10,000 during the same 4-hour period OR ADT > 35,000 IF Vehicle speed > 45 MPH AND The proposed sites are in urban areas. ELSE, vehicle volume > 7,500 in 4 hours OR ADT > 25,000 **#2.** Minimum average hourly volume 600 during 8 hours of an average day, combined with a minimum average hourly pedestrian volume 150. **#3.** ***On freeways***, the minimum of 100 pedestrians or bicyclists during any 4-hour period, 7,500 vehicles during the same 4-hour period, and an AADT of 25,000. ***On arterials***, the minimum of 300 pedestrians or bicyclists during any 4-hour period, 10,000 vehicles during the same 4- hour period, and an AADT of 35,000. **#4.** Vehicle volume should be over 10,000 in the same 4 hour period used for the pedestrian volume warrant or ADT over 35,000 if both vehicle speed is over 40 mph and the proposed sites are in urban areas. If the two conditions are not met, vehicle volume should be over 7,500 in 4 hours or ADT over 25,000.	**#1.** Bowman et al. (1989) as cited in **#2.** Alaska DOT **#3.** Louisiana DOT **#4.** Axler (1984)
Accident history	**#1.** IF pedestrian volume data are not available OR instead of pedestrian volumes, consider GSPC IF, along a 300m road segment with no crossing facilities, there have been 3 or more pedestrian-vehicle crashes in 10 years, 2 or more in 5 years, OR 2 or more in 3 years.	**#1.** FPPD(1999)
Availability of alternative crossings	**#1.** The proposed site is > 600feet (182m) from the nearest “safe” crossing. A “safe” crossing is where a traffic control device stops vehicles to create adequate gaps for pedestrians to cross or an existing over or underpass near the proposed one. **#2.** There is no alternative crossing within 150 m of the candidate location for overpass.	**#1.** Bowman et al. (1989) **2#.** FPPD(1999)
Geometric conditions	**#1.** If available sight distance is less than the stopping sight distance required by the 85th percentile approach speed, and no other crossings are available within a distance of 150m from the overpass. **#2.** Where a freeway intersects a pedestrian way where no vehicular structure is to be built, and no other pedestrian crossing of the freeway is available within 150m. **#3.** A grade-separated crossing is needed when a highway is six or more lanes.	**#1.** Alaska DOT **#2.** FPPD(1999) **#3**. Alaska DOT
Miscellaneous considerations	**#1.** Consider a GSPC when - Two activity centers are separated by a roadway. - The crossing would serve a well-defined origin-destination pair, such as a school and a residential area, a parking facility and a shopping center, a neighborhood and a park, a transit stop and a campus, etc., & there is a need to prevent or offer an alternative at-grade crossings OR there are natural or man-made barriers to pedestrian crossings OR alternative crossing routes are long and circuitous OR there is community support for a grade-separated crossing. **#2.** If a specific need exist or be projected for a GSPC based on existing or proposed land use(s) adjoining the proposed site which generate pedestrian trips. These land use(s) should have direct access to the GSPC. **#3.** A GSPC may still be appropriate despite the availability of a nearby crossing if the pedestrian demand is substantially greater than the minimum required for the warrant, or if grade differences make installation of an over or underpass especially convenient.	**#1.** FPPD(1999) **#2.** Axler (1984) **#3**. Ottawa DOT (2009)

Table 4.31: Checked warrants for the provision of additional GSPCs along the Addis Ababa Ring Road.

Considerations	Warrants	Bole Intl Airport Cargo Terminal (54+20)	Mammo (71+06)	Saris Gulit or Bulbula School (92+38)	Kadisco (Kadisco Asia Paints) (125+48)
Pedestrian volume	**#1**	✓	✓	✓	✓
	#2	✓	✓	✓	X
	#3	✓	✓	✓	✓
	#4	✓	✓	✓	✓
	#5	✓	✓	✓	✓
Traffic speeds	**#1**	✓	✓	✓	✓
Vehicular volumes	**#1**	-	-	-	-
	#2	✓	✓	✓	✓
	#3	✓	✓	✓	✓
	#4	✓	✓	✓	✓
Accident history	**#1**	-	-	-	-
Availability of alternative crossings	**#1**	✓	✓	✓	✓
	#2	✓	✓	✓	✓
Geometric Conditions	**#1**	✓	✓	✓	✓
	#2	✓	✓	✓	✓
	#3	✓	✓	✓	✓
Miscellaneous Considerations	**#1**	✓	✓	✓	✓
	#2	X	X	X	X
	#3	✓	✓	✓	✓

NB: The stations are referenced from Megenagna (0+00) where the study route starts.

Since most of the warrants (including warrants of pedestrian volume, traffic speed, availability of crossing and geometric warrants) are met, provision of additional pedestrian overpass facilities with accessible components for elderly and mobility impaired pedestrians at these locations is highly recommended by the researcher. Some measures had been took so far to reduce illegal crossings along the Addis Ababa Ring Road though the impacts are not satisfactory and some of them were not consistently applied.

- Additional metal fences were erected on the top of the two inner concrete barriers intended to increase the heights so that pedestrians get it difficult to jump over it. This was applied at few parts of the road; does not cover the whole part. The additional fences erected on the concrete barriers does not seem to prevent pedestrians from jaywalk crossing, rather it seems to exacerbate the problem as pedestrians use it as ladder and easily grab and jump over the barriers because its height is still climbable. Where the heights of fences was greater than 2.0m, the pedestrians do not jump at all since it is unclimbable.
- Charging 80 Birr of those found crossing the Ring Road illegally was being applied for few months in the past. This seems effective means of enforcement to reduce illegal crossing but requires manpower and consistent regulation; though currently not being applied for unknown reason. In addition to this, protecting the Ring Road with law enforcement agents such as police force on random days and locations was tried.

CHAPTER – 5

CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

- The analysis results of utilization rates of the overpass facilities along the Addis Ababa Ring Road shows that substantial volume of pedestrians do not use nearby facilities and cross over barriers illegally.
- Time saving, lack of awareness, absence of law enforcement and perception that the facility is far from origin/destination point are the main reasons that made most pedestrians not to use overpasses whereas vibration (shaking) of the overpasses, low volume of traffic at-grade, poor attractiveness of the facilities and congestion on the facilities are not significant factors for not using the overpasses.
- Though most pedestrian comprehend the risk of illegal crossing, perceive it 'Very Dangerous' and know that it is punishable by the traffic law of the country (74% users and 79% of non-users are aware of the law), enforcement is not consistently applied for those who violate the law.
- The top three factors considered by users in their decision to select crossing alternatives (at grade vs overpasses) are *safety*, *distance* and *time*; whereas non-users consider *time*, *distance* and *safety*. Factors with almost negligible effect in the decision making process to select crossing alternatives include attractiveness of the facilities, energy, vehicular traffic volume at grade level and comfort.
- At the peak periods of the day, the overpass facilities along the Ring Road are capable of accommodating all users and non-users within up to half distance of the facilities with a PLOS-A, B or C.
- All of the overpasses fulfill the requirement of basic area for standing pedestrian and an area to evaluate pedestrian facility as a buffer zone. The capacity is good enough to serve all non-users (if diverted to the facility and utilized 100%) because a V/C ratio of less than 1.0 was found. Therefore, the overpasses along the study route serve well below their capacities.
- The overpass facilities take almost twice of the time required to cross the Ring Road at grade level, hence are characterized by their in-convenience ($R>1$). Thus, it is clear that pedestrians stated time saving as a predominant factor that leads them to cross illegally.
- Most spacing of the facilities are not within acceptable walking distance range. The design of the overpass facilities are not accessible and do not fulfill the requirements of elderly and disabled pedestrians, lack wheelchair accessible ramps and smooth transition between sidewalks and the facilities.

5.2. Recommendations

Based on the study, the following recommendations are forwarded.

- Since most of the warrants (pedestrian volume warrants, traffic speed warrants, availability of crossing warrants and geometric warrants) are met, provision of pedestrian overpass facilities with accessible components such as level transition from the sidewalk to the facility, ramps and handrails for elderly and mobility impaired pedestrians is highly recommended at *Bole International Airport Cargo Terminal* (54+20), *Mammo* (71+06), *Saris Gulit or Bulbula School* (92+38) and *Kadisco* (125+48).
- The information that it is punishable to cross the Ring Road over barriers is not communicated well. Not only non-users but also user pedestrians are unaware of this law or not heard of it at all. Therefore, launching awareness-raising campaigns that provide information to pedestrians on the possible risks (including legal consequences) of illegally crossing the road is essential.
- A fine similar to a parking ticket must be issued to pedestrians violating the rules consistently. Those found of breaking the law shall be forced to give free social services if not able to pay money. Illegal pedestrians shall be equivalently treated as drivers when found violating the traffic rules of the country.
- Information and awareness campaigns, additional provision of crossing facilities, improving accessibility for elderly and disabled, reduce spacing between facilities (may be by additional provision or appropriately locating the facilities) and punishment/enforcement are among the lists by decreasing order of importance to reduce the problem. Aesthetic enhancement, increasing height of barriers/ fences, removing illegal vendors and beggars are also suggested to reduce the problem.
- Elevation difference between carriageways and the metal fences on the top of the concrete barriers seem to discourage at grade crossing hence a high rate of utilization of pedestrian overpass is attained. Future provisions in the city shall consider these.
- Elevated barriers or fences shall be placed along the at-grade crossing to give visual cues to pedestrians to use overpasses. However, proper placement should be the first choice in future works.
- Overpasses must meet several design requirements including being accessible to all pedestrians; access ramps must be provided (in future works, stairs may be provided in addition to ramps, not instead of ramps) and on the existing overpasses, a level transition between the sidewalk and stairs can be introduced.
- Since the road is built for mobility not for access, the heights of fences/barriers need to be as high as 2.0m so that no pedestrian is able to jump over the barriers. It was found that at overpasses where the barrier height is increased by additional metal fences on the top of the concrete, higher utilization rate value was attained as compared to overpasses with no additional metal fences on the concrete barrier.

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APENDICES

Appendix-A: Pedestrian Count Formats

Table A.1: Pedestrian Count Crossing the Ring Road With or Without Using Pedestrian Overpasses

Date		Pedestrian Overpass Designation	
Day of the Week		Location (Reference Landmark)	

Time Intervals	Number of non-user pedestrians (within 100m-Left Side)		Number of non-user Pedestrians (within 100m-Right Side)		Overpass Users	
	M	F	M	F	M	F
8:00-8:15AM						
8:15-8:30AM						
8:30-8:45AM						
8:45-9:00AM						
8:00-9:15AM						
9:15-9:30AM						
9:30-9:45AM						
9:45-10:00AM						
10:00-10:15AM						
10:15-10:30AM						
10:30-10:45AM						
10:45-11:00AM						
11:00-11:15AM						
11:15-11:30AM						
11:30-11:45AM						
11:45AM -12:00PM						
2:00-2:15PM						
2:15-2:30PM						
2:30-2:45PM						
2:45-3:00PM						
3:00-3:15PM						
3:15-3:30PM						
3:30-3:45PM						
3:45-4:00PM						
4:00-4:15PM						
4:15-4:30PM						
4:30-4:45PM						
4:45-4:00PM						
5:00-4:15PM						
5:15-5:30PM						
5:30-5:45PM						
5:45-6:00PM						

Table A.2: Pedestrian Count at Critical Places along the Ring Road where the Highest Illegal Crossing Activity Exits Mainly Due to Lack of Alternative Crossing Facility

Time Interval	Places where the counting is carried out															
	In front of Bole International Airport Cargo Terminal				Mammo (Agaziyan, Sibiste and Nifas Silk Schools exist)				In front of Bulbula School OR Saris Local Market Entry				In Front of KADISCO Asian Paints			
	M	F	V_{15}	Hourly Vol.	M	F	V_{15}	Hourly Vol.	M	F	V_{15}	Hourly Vol.	M	F	V_{15}	Hourly Vol.
8:00-8:15AM	53	10	63	X	66	14	80	X	117	23	140	X	51	19	70	X
8:15-8:30AM	42	12	54	X	69	25	94	X	108	33	141	X	49	11	60	X
8:30-8:45AM	36	5	41	X	40	16	56	X	109	42	151	X	56	6	62	X
8:45-9:00AM	44	7	51	209	46	13	59	289	92	48	140	572	35	12	47	239
8:00-9:15AM	40	10	50	196	44	14	58	267	108	35	143	575	9	5	14	183
9:15-9:30AM	40	8	48	190	44	18	62	235	110	38	148	582	19	2	21	144
9:30-9:45AM	29	4	33	182	53	10	63	242	103	54	157	588	15	2	17	99
9:45-10:00AM	38	14	52	183	44	11	55	238	100	45	145	593	17	2	19	71
10:00-10:15AM	24	11	35	168	48	7	55	235	115	39	154	604	13	7	20	77
10:15-10:30AM	23	8	31	151	52	16	68	241	109	42	151	607	16	5	21	77
10:30-10:45AM	39	10	49	167	42	15	57	235	98	31	129	579	17	5	22	82
10:45-11:00AM	42	12	54	169	45	13	58	238	100	38	138	572	17	1	18	81
11:00-11:15AM	37	4	41	175	44	6	50	233	97	34	131	549	13	5	18	79
11:15-11:30AM	31	1	32	176	33	9	42	207	103	48	151	549	24	1	25	83
11:30-11:45AM	38	3	41	168	42	13	55	205	91	39	130	550	14	3	17	78
11:45AM -12:00PM	30	1	31	145	46	15	61	208	104	47	151	563	25	10	35	95
2:00-2:15PM	42	10	52	X	41	11	52	X	111	40	151	X	58	17	75	X
2:15-2:30PM	45	9	54	X	35	14	49	X	94	35	129	X	43	6	49	X
2:30-2:45PM	43	8	51	X	58	9	67	X	115	27	142	X	43	6	49	X
2:45-3:00PM	35	6	41	198	65	7	72	240	107	55	162	584	38	6	44	217
3:00-3:15PM	49	6	55	201	45	9	54	242	81	40	121	554	39	2	41	183
3:15-3:30PM	28	1	29	176	55	12	67	260	110	31	141	566	39	5	44	178
3:30-3:45PM	26	5	31	156	25	10	35	228	116	34	150	574	31	11	42	171
3:45-4:00PM	32	4	36	151	55	13	68	224	106	57	163	575	40	4	44	171
4:00-4:15PM	31	5	36	132	37	14	51	221	101	54	155	609	48	2	50	180
4:15-4:30PM	25	1	26	129	50	25	75	229	102	40	142	610	35	1	36	172
4:30-4:45PM	32	2	34	132	56	8	64	258	105	48	153	613	27	5	32	162
4:45-4:00PM	38	2	40	136	46	12	58	248	107	62	169	619	51	9	60	178
5:00-4:15PM	37	2	39	139	69	23	92	289	107	47	154	618	60	8	68	196
5:15-5:30PM	40	4	44	157	87	14	101	315	117	50	167	643	61	15	76	236
5:30-5:45PM	36	4	40	163	87	26	113	364	155	58	213	703	53	18	71	275
5:45-6:00PM	22	1	23	146	80	15	95	401	147	42	189	723	47	12	59	274
Total	1147	190	1337	--	1649	437	2086	--	3445	1356	4801	--	1103	223	1326	--
Average	36	6	42	165	52	14	65	254	108	42	150	595	34	7	41	153

Table A.3: Pedestrian Count Data, Peak Volumes & Diverted Volumes from Different Distances

Nyala Motors/ Anbesa Garage (OP – 1) — 750m | OP-1 | 350m — Day-1

Pedestrian Counts — Counting Date-Tuesday (October 10/2017)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left & 100m Right)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	7.5L	3.5R	Sum (7.5L+3.5R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	24	0	7	0	239	152	391	24	7	31	180	25	205	391	422	596
8:15-8:30AM	36	0	8	3	176	107	283	36	11	47	270	39	309	283	330	592
8:30-8:45AM	40	2	3	1	107	77	184	42	4	46	315	14	329	184	230	513
8:45-9:00AM	22	3	2	0	106	73	179	25	2	27	188	7	195	179	206	374
9:00-9:15AM	26	1	3	2	97	82	179	27	5	32	203	18	220	179	211	399
9:15-9:30AM	17	1	1	0	85	44	129	18	1	19	135	4	139	129	148	268
9:30-9:45AM	11	0	2	0	79	54	133	11	2	13	83	7	90	133	146	223
9:45-10:00AM	13	0	9	0	74	51	125	13	9	22	98	32	129	125	147	254
10:00-10:15AM	28	0	0	0	65	37	102	28	0	28	210	0	210	102	130	312
10:15-10:30AM	19	1	1	0	73	27	100	20	1	21	150	4	154	100	121	254
10:30-10:45AM	15	0	0	0	56	41	97	15	0	15	113	0	113	97	112	210
10:45-11:00AM	7	0	0	0	67	47	114	7	0	7	53	0	53	114	121	167
11:00-11:15AM	8	0	0	0	53	26	79	8	0	8	60	0	60	79	87	139
11:15-11:30AM	12	0	4	2	59	30	89	12	6	18	90	21	111	89	107	200
11:30-11:45AM	15	1	0	0	58	24	82	16	0	16	120	0	120	82	98	202
11:45AM-12:00PM	10	0	0	0	59	35	94	10	0	10	75	0	75	94	104	169
2:00-2:15PM	9	0	3	3	54	29	83	9	6	15	68	21	89	83	98	172
2:15-2:30PM	12	3	1	0	73	29	102	15	1	16	113	4	116	102	118	218
2:30-2:45PM	20	1	3	1	73	26	99	21	4	25	158	14	172	99	124	271
2:45-3:00PM	13	0	3	0	61	40	101	13	3	16	98	11	108	101	117	209
3:00-3:15PM	14	0	1	0	64	41	105	14	1	15	105	4	109	105	120	214
3:15-3:30PM	24	2	0	0	61	41	102	26	0	26	195	0	195	102	128	297
3:30-3:45PM	20	0	1	0	73	64	137	20	1	21	150	4	154	137	158	291
3:45-4:00PM	25	0	3	0	101	58	159	25	3	28	188	11	198	159	187	357
4:00-4:15PM	15	1	4	0	81	44	125	16	4	20	120	14	134	125	145	259
4:15-4:30PM	24	0	1	1	76	54	130	24	2	26	180	7	187	130	156	317
4:30-4:45PM	26	0	1	0	108	74	182	26	1	27	195	4	199	182	209	381
4:45-5:00PM	18	0	2	0	112	54	166	18	2	20	135	7	142	166	186	308
5:00-5:15PM	52	1	3	0	167	122	289	53	3	56	398	11	408	289	345	697
5:15-5:30PM	32	2	11	0	137	97	234	34	11	45	255	39	294	234	279	528
5:30-5:45PM	34	1	5	1	163	103	266	35	6	41	263	21	284	266	307	550
5:45-6:00PM	33	0	2	0	117	91	208	33	2	35	248	7	255	208	243	463
Total	674	20	84	14	2974	1874	4848	694	98	792	5205	343	5548	4848	5640	10396

Nyala Motors/ Anbesa Garage (OP – 1) — 750m | OP-1 | 350m — Day-2

Pedestrian Counts — Counting Date-Monday (April 23/2018)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left & 100m Right)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	7.5L	3.5R	Sum (7.5L+3.5R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	22	0	6	1	263	134	397	22	7	29	165	25	190	397	426	587
8:15-8:30AM	23	3	6	4	225	168	393	26	10	36	195	35	230	393	429	623
8:30-8:45AM	41	1	1	0	105	84	189	42	1	43	315	4	319	189	232	508
8:45-9:00AM	19	0	2	0	145	77	222	19	2	21	143	7	150	222	243	372
9:00-9:15AM	26	5	1	1	78	87	165	31	2	33	233	7	240	165	198	405
9:15-9:30AM	19	1	3	1	87	44	131	20	4	24	150	14	164	131	155	295
9:30-9:45AM	15	0	2	0	80	59	139	15	2	17	113	7	120	139	156	259
9:45-10:00AM	14	0	6	0	76	49	125	14	6	20	105	21	126	125	145	251
10:00-10:15AM	31	1	1	0	63	41	104	32	1	33	240	4	244	104	137	348
10:15-10:30AM	20	0	1	0	62	33	95	20	1	21	150	4	154	95	116	249
10:30-10:45AM	23	0	4	0	49	38	87	23	4	27	173	14	187	87	114	274
10:45-11:00AM	6	1	1	1	71	33	104	7	2	9	53	7	60	104	113	164
11:00-11:15AM	6	0	1	1	47	29	76	6	2	8	45	7	52	76	84	128
11:15-11:30AM	15	2	0	2	55	28	83	17	2	19	128	7	135	83	102	218
11:30-11:45AM	8	0	1	0	47	29	76	8	1	9	60	4	64	76	85	140
11:45AM-12:00PM	8	0	0	1	66	35	101	8	1	9	60	4	64	101	110	165
2:00-2:15PM	14	1	0	2	54	25	79	15	2	17	113	7	120	79	96	199
2:15-2:30PM	9	2	0	2	70	33	103	11	2	13	83	7	90	103	116	193
2:30-2:45PM	18	1	0	1	75	30	105	19	1	20	143	4	146	105	125	251
2:45-3:00PM	13	3	1	0	59	39	98	16	1	17	120	4	124	98	115	222
3:00-3:15PM	15	0	1	1	60	49	109	15	2	17	113	7	120	109	126	229
3:15-3:30PM	14	1	0	0	73	40	113	15	0	15	113	0	113	113	128	226
3:30-3:45PM	23	0	1	0	72	60	132	23	1	24	173	4	176	132	156	308
3:45-4:00PM	27	0	1	0	96	62	158	27	1	28	203	4	206	158	186	364
4:00-4:15PM	15	1	3	0	82	50	132	16	3	19	120	11	131	132	151	263
4:15-4:30PM	25	0	1	1	70	44	114	25	2	27	188	7	195	114	141	309
4:30-4:45PM	29	0	1	0	99	65	164	29	1	30	218	4	221	164	194	385
4:45-5:00PM	15	0	2	2	120	71	191	15	4	19	113	14	127	191	210	318
5:00-5:15PM	55	0	3	0	159	134	293	55	3	58	413	11	423	293	351	716
5:15-5:30PM	58	3	12	1	140	90	230	61	13	74	458	46	503	230	304	733
5:30-5:45PM	27	0	6	0	165	97	262	27	6	33	203	21	224	262	295	486
5:45-6:00PM	36	1	3	0	121	98	219	37	3	40	278	11	288	219	259	507
Total	689	27	71	22	3034	1955	4989	716	93	809	5370	325.5	5696	4989	5798	10685

Nyala Motors/ Anbesa Garage (OP – 1) — 750m | OP-1 | 350m — Day-3

Pedestrian Counts — Counting Date-Thursday (April 26/2018)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left & 100m Right)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	7.5L	3.5R	Sum (7.5L+3.5R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	30	3	8	1	217	121	338	33	9	42	248	32	279	338	380	617
8:15-8:30AM	35	0	7	2	162	91	253	35	9	44	263	32	294	253	297	547
8:30-8:45AM	33	2	4	1	105	58	163	35	5	40	263	18	280	163	203	443
8:45-9:00AM	29	3	2	3	100	63	163	32	5	37	240	18	258	163	200	421
9:00-9:15AM	26	3	5	0	83	72	155	29	5	34	218	18	235	155	189	390
9:15-9:30AM	22	1	1	0	84	38	122	23	1	24	173	4	176	122	146	298
9:30-9:45AM	11	0	1	3	84	47	131	11	4	15	83	14	97	131	146	228
9:45-10:00AM	17	2	12	0	63	42	105	19	12	31	143	42	185	105	136	290
10:00-10:15AM	19	0	8	0	59	22	81	19	8	27	143	28	171	81	108	252
10:15-10:30AM	21	1	1	2	67	21	88	22	3	25	165	11	176	88	113	264
10:30-10:45AM	17	1	0	1	49	33	82	18	1	19	135	4	139	82	101	221
10:45-11:00AM	12	1	4	0	51	27	78	13	4	17	98	14	112	78	95	190
11:00-11:15AM	8	1	1	0	48	21	69	9	1	10	68	4	71	69	79	140
11:15-11:30AM	13	0	2	3	52	19	71	13	5	18	98	18	115	71	89	186
11:30-11:45AM	11	2	0	1	54	21	75	13	1	14	98	4	101	75	89	176
11:45AM-12:00PM	8	1	3	0	55	23	78	9	3	12	68	11	78	78	90	156
2:00-2:15PM	7	0	4	0	25	23	48	7	4	11	53	14	67	48	59	115
2:15-2:30PM	13	2	5	3	54	25	79	15	8	23	113	28	141	79	102	220
2:30-2:45PM	16	2	4	2	61	19	80	18	6	24	135	21	156	80	104	236
2:45-3:00PM	10	1	2	1	67	20	87	11	3	14	83	11	93	87	101	180
3:00-3:15PM	14	0	1	0	59	33	92	14	1	15	105	4	109	92	107	201
3:15-3:30PM	17	1	0	0	46	41	87	18	0	18	135	0	135	87	105	222
3:30-3:45PM	17	3	2	0	67	53	120	20	2	22	150	7	157	120	142	277
3:45-4:00PM	23	0	1	0	87	51	138	23	1	24	173	4	176	138	162	314
4:00-4:15PM	21	1	3	4	86	42	128	22	7	29	165	25	190	128	157	318
4:15-4:30PM	26	0	7	2	79	54	133	26	9	35	195	32	227	133	168	360
4:30-4:45PM	19	2	9	0	102	67	169	21	9	30	158	32	189	169	199	358
4:45-5:00PM	20	0	6	0	129	52	181	20	6	26	150	21	171	181	207	352
5:00-5:15PM	42	1	3	1	136	85	221	43	4	47	323	14	337	221	268	558
5:15-5:30PM	35	0	8	2	118	71	189	35	10	45	263	35	298	189	234	487
5:30-5:45PM	47	1	8	0	119	85	204	48	8	56	360	28	388	204	260	592
5:45-6:00PM	24	0	6	3	99	87	186	24	9	33	180	32	212	186	219	398
Total	663	35	128	35	2667	1527	4194	698	163	861	5235	570.5	5806	4194	5055	10000

Hayat Hospital (OP – 2) | 475m | OP-2 | 250m | Day-1

Pedestrian Counts — Counting Date- Wednesday (Oct. 11/2017)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left &100m Right)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	4.75L	2.5R	Sum (4.75L+2.5R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	3	0	3	0	60	43	103	3	3	6	14	8	22	103	109	125
8:15-8:30AM	1	0	3	0	48	24	72	1	3	4	5	8	12	72	76	84
8:30-8:45AM	2	0	7	0	50	35	85	2	7	9	10	18	27	85	94	112
8:45-9:00AM	1	0	7	0	57	28	85	1	7	8	5	18	22	85	93	107
9:00-9:15AM	0	0	6	0	51	28	79	0	6	6	0	15	15	79	85	94
9:15-9:30AM	0	0	3	0	40	23	63	0	3	3	0	8	8	63	66	71
9:30-9:45AM	0	0	0	0	45	20	65	0	0	0	0	0	0	65	65	65
9:45-10:00AM	4	0	3	0	39	24	63	4	3	7	19	8	27	63	70	90
10:00-10:15AM	3	0	3	1	44	23	67	3	4	7	14	10	24	67	74	91
10:15-10:30AM	1	0	4	0	46	19	65	1	4	5	5	10	15	65	70	80
10:30-10:45AM	1	0	1	0	44	23	67	1	1	2	5	3	7	67	69	74
10:45-11:00AM	1	0	4	0	39	15	54	1	4	5	5	10	15	54	59	69
11:00-11:15AM	1	0	12	0	39	13	52	1	12	13	5	30	35	52	65	87
11:15-11:30AM	5	0	3	0	31	21	52	5	3	8	24	8	31	52	60	83
11:30-11:45AM	0	0	2	0	44	19	63	0	2	2	0	5	5	63	65	68
11:45AM-12:00PM	2	0	1	0	25	19	44	2	1	3	10	3	12	44	47	56
2:00-2:15PM	0	0	4	0	48	15	63	0	4	4	0	10	10	63	67	73
2:15-2:30PM	4	0	2	0	38	19	57	4	2	6	19	5	24	57	63	81
2:30-2:45PM	0	0	1	0	43	15	58	0	1	1	0	3	3	58	59	61
2:45-3:00PM	2	0	2	1	44	31	75	2	3	5	10	8	17	75	80	92
3:00-3:15PM	0	0	2	0	22	28	50	0	2	2	0	5	5	50	52	55
3:15-3:30PM	1	0	1	0	36	23	59	1	1	2	5	3	7	59	61	66
3:30-3:45PM	1	0	3	0	50	38	88	1	3	4	5	8	12	88	92	100
3:45-4:00PM	2	0	2	0	49	26	75	2	2	4	10	5	15	75	79	90
4:00-4:15PM	1	0	4	0	55	30	85	1	4	5	5	10	15	85	90	100
4:15-4:30PM	2	0	2	0	35	22	57	2	2	4	10	5	15	57	61	72
4:30-4:45PM	3	0	4	2	44	21	65	3	6	9	14	15	29	65	74	94
4:45-5:00PM	0	0	2	0	46	34	80	0	2	2	0	5	5	80	82	85
5:00-5:15PM	1	0	2	0	52	32	84	1	2	3	5	5	10	84	87	94
5:15-5:30PM	2	0	6	0	68	36	104	2	6	8	10	15	25	104	112	129
5:30-5:45PM	0	0	0	0	54	14	68	0	0	0	0	0	0	68	68	68
5:45-6:00PM	4	0	0	0	66	21	87	4	0	4	19	0	19	87	91	106
Total	48	0	99	4	1452	782	2234	48	103	151	228	257.5	486	2234	2385	2720

Hayat Hospital (OP – 2) | 475m | OP-2 | 250m | Day-2

Pedestrian Counts — Counting Date-Tuesday (April 24/2018)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left &100m Right)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	4.75L	2.5R	Sum (4.75L+2.5R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	1	0	3	0	71	39	110	1	3	4	5	8	12	110	114	122
8:15-8:30AM	3	1	3	0	78	13	91	4	3	7	19	8	27	91	98	118
8:30-8:45AM	2	0	4	2	82	21	103	2	6	8	10	15	25	103	111	128
8:45-9:00AM	1	1	3	0	49	32	81	2	3	5	10	8	17	81	86	98
9:00-9:15AM	0	0	11	1	67	21	88	0	12	12	0	30	30	88	100	118
9:15-9:30AM	3	0	0	1	55	54	109	3	1	4	14	3	17	109	113	126
9:30-9:45AM	1	2	0	0	49	33	82	3	0	3	14	0	14	82	85	96
9:45-10:00AM	0	0	2	1	46	34	80	0	3	3	0	8	8	80	83	88
10:00-10:15AM	1	0	3	0	52	19	71	1	3	4	5	8	12	71	75	83
10:15-10:30AM	1	0	1	0	61	20	81	1	1	2	5	3	7	81	83	88
10:30-10:45AM	0	0	1	0	42	28	70	0	1	1	0	3	3	70	71	73
10:45-11:00AM	1	1	0	0	33	21	54	2	0	2	10	0	10	54	56	64
11:00-11:15AM	1	0	6	1	42	19	61	1	7	8	5	18	22	61	69	83
11:15-11:30AM	2	0	2	1	32	20	52	2	3	5	10	8	17	52	57	69
11:30-11:45AM	1	1	2	0	25	19	44	2	2	4	10	5	15	44	48	59
11:45AM-12:00PM	2	0	1	1	37	13	50	2	2	4	10	5	15	50	54	65
2:00-2:15PM	1	1	4	0	49	14	63	2	4	6	10	10	20	63	69	83
2:15-2:30PM	1	0	2	1	43	16	59	1	3	4	5	8	12	59	63	71
2:30-2:45PM	2	1	1	0	40	14	54	3	1	4	14	3	17	54	58	71
2:45-3:00PM	2	0	1	1	54	24	78	2	2	4	10	5	15	78	82	93
3:00-3:15PM	1	0	2	0	23	20	43	1	2	3	5	5	10	43	46	53
3:15-3:30PM	0	1	1	1	35	23	58	1	2	3	5	5	10	58	61	68
3:30-3:45PM	1	0	1	0	51	30	81	1	1	2	5	3	7	81	83	88
3:45-4:00PM	1	1	2	0	44	30	74	2	2	4	10	5	15	74	78	89
4:00-4:15PM	3	1	2	0	61	29	90	4	2	6	19	5	24	90	96	114
4:15-4:30PM	2	1	1	1	42	24	66	3	2	5	14	5	19	66	71	85
4:30-4:45PM	1	0	6	2	41	26	67	1	8	9	5	20	25	67	76	92
4:45-5:00PM	1	0	2	0	48	39	87	1	2	3	5	5	10	87	90	97
5:00-5:15PM	2	1	2	0	55	35	90	3	2	5	14	5	19	90	95	109
5:15-5:30PM	1	0	2	1	66	37	103	1	3	4	5	8	12	103	107	115
5:30-5:45PM	1	1	3	0	59	20	79	2	3	5	10	8	17	79	84	96
5:45-6:00PM	2	1	2	1	56	33	89	3	3	6	14	8	22	89	95	111
Total	42	15	76	16	1588	820	2408	57	92	149	271	230	501	2408	2557	2909

Hayat Hospital (OP – 2) | 475m | OP-2 | 250m | Day-3

Pedestrian Counts — Counting Date-Thursday (April 26/2018)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left &100m Right)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	4.75L	2.5R	Sum (4.75L+2.5R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	2	1	3	0	52	42	94	3	3	6	14	8	22	94	100	116
8:15-8:30AM	3	0	4	0	51	27	78	3	4	7	14	10	24	78	85	102
8:30-8:45AM	0	0	5	1	31	34	65	0	6	6	0	15	15	65	71	80
8:45-9:00AM	4	0	8	0	41	33	74	4	8	12	19	20	39	74	86	113
9:00-9:15AM	0	0	5	0	46	21	67	0	5	5	0	13	13	67	72	80
9:15-9:30AM	0	0	3	0	35	20	55	0	3	3	0	8	8	55	58	63
9:30-9:45AM	5	1	0	0	41	20	61	6	0	6	29	0	29	61	67	90
9:45-10:00AM	0	0	3	0	39	22	61	0	3	3	0	8	8	61	64	69
10:00-10:15AM	3	0	1	1	39	18	57	3	2	5	14	5	19	57	62	76
10:15-10:30AM	1	0	5	1	44	21	65	1	6	7	5	15	20	65	72	85
10:30-10:45AM	1	0	1	0	44	22	66	1	1	2	5	3	7	66	68	73
10:45-11:00AM	1	0	4	0	35	11	46	1	4	5	5	10	15	46	51	61
11:00-11:15AM	3	0	6	0	32	11	43	3	6	9	14	15	29	43	52	72
11:15-11:30AM	5	0	3	0	29	25	54	5	3	8	24	8	31	54	62	85
11:30-11:45AM	0	0	3	1	38	20	58	0	4	4	0	10	10	58	62	68
11:45AM-12:00PM	3	0	0	0	32	12	44	3	0	3	14	0	14	44	47	58
2:00-2:15PM	2	0	0	0	39	16	55	2	0	2	10	0	10	55	57	65
2:15-2:30PM	4	0	2	0	36	14	50	4	2	6	19	5	24	50	56	74
2:30-2:45PM	0	0	1	0	40	17	57	0	1	1	0	3	3	57	58	60
2:45-3:00PM	2	0	2	1	37	29	66	2	3	5	10	8	17	66	71	83
3:00-3:15PM	0	0	2	0	20	28	48	0	2	2	0	5	5	48	50	53
3:15-3:30PM	1	0	1	0	30	16	46	1	1	2	5	3	7	46	48	53
3:30-3:45PM	3	0	3	0	42	38	80	3	3	6	14	8	22	80	86	102
3:45-4:00PM	3	0	3	0	49	21	70	3	3	6	14	8	22	70	76	92
4:00-4:15PM	0	0	2	0	56	31	87	0	2	2	0	5	5	87	89	92
4:15-4:30PM	3	0	2	0	29	22	51	3	2	5	14	5	19	51	56	70
4:30-4:45PM	0	0	4	2	46	19	65	0	6	6	0	15	15	65	71	80
4:45-5:00PM	0	1	2	0	45	29	74	1	2	3	5	5	10	74	77	84
5:00-5:15PM	6	0	3	0	47	29	76	6	3	9	29	8	36	76	85	112
5:15-5:30PM	1	0	6	0	68	29	97	1	6	7	5	15	20	97	104	117
5:30-5:45PM	1	0	1	0	50	15	65	1	1	2	5	3	7	65	67	72
5:45-6:00PM	0	0	1	1	54	26	80	0	2	2	0	5	5	80	82	85
Total	57	3	89	8	1317	738	2055	60	97	157	285	242.5	528	2055	2212	2583

Bole Mikael (OP-3)											152m	OP-3	1000m	Day-1		
Pedestrian Counts	Counting Date-Thursday(October 12/2017)															
Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	1.52L	10.0R	Sum (1.52L+10R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	6	0	7	0	180	220	400	6	7	13	9	70	79	400	413	479
8:15-8:30AM	4	0	7	0	165	190	355	4	7	11	6	70	76	355	366	431
8:30-8:45AM	4	2	10	4	150	143	293	6	14	20	9	140	149	293	313	442
8:45-9:00AM	10	0	9	0	167	179	346	10	9	19	15	90	105	346	365	451
9:00-9:15AM	15	0	10	0	149	167	316	15	10	25	23	100	123	316	341	439
9:15-9:30AM	17	0	7	0	125	108	233	17	7	24	26	70	96	233	257	329
9:30-9:45AM	5	0	6	0	127	95	222	5	6	11	8	60	68	222	233	290
9:45-10:00AM	12	2	5	0	139	109	248	14	5	19	21	50	71	248	267	319
10:00-10:15AM	18	0	10	0	135	115	250	18	10	28	27	100	127	250	278	377
10:15-10:30AM	20	0	7	0	139	142	281	20	7	27	30	70	100	281	308	381
10:30-10:45AM	15	0	12	0	108	126	234	15	12	27	23	120	143	234	261	377
10:45-11:00AM	12	0	14	0	124	119	243	12	14	26	18	140	158	243	269	401
11:00-11:15AM	22	0	7	0	110	121	231	22	7	29	33	70	103	231	260	334
11:15-11:30AM	17	0	8	0	124	90	214	17	8	25	26	80	106	214	239	320
11:30-11:45AM	11	0	4	0	84	88	172	11	4	15	17	40	57	172	187	229
11:45AM-12:00PM	21	3	8	1	87	121	208	24	9	33	36	90	126	208	241	334
2:00-2:15PM	15	1	4	0	80	72	152	16	4	20	24	40	64	152	172	216
2:15-2:30PM	10	0	8	0	111	99	210	10	8	18	15	80	95	210	228	305
2:30-2:45PM	13	0	5	0	102	85	187	13	5	18	20	50	70	187	205	257
2:45-3:00PM	15	1	1	0	96	88	184	16	1	17	24	10	34	184	201	218
3:00-3:15PM	11	0	8	0	118	117	235	11	8	19	17	80	97	235	254	332
3:15-3:30PM	11	2	4	0	107	150	257	13	4	17	20	40	60	257	274	317
3:30-3:45PM	19	7	11	2	139	147	286	26	13	39	40	130	170	286	325	456
3:45-4:00PM	23	2	17	0	202	264	466	25	17	42	38	170	208	466	508	674
4:00-4:15PM	17	0	7	0	172	174	346	17	7	24	26	70	96	346	370	442
4:15-4:30PM	11	2	5	0	106	156	262	13	5	18	20	50	70	262	280	332
4:30-4:45PM	17	0	2	0	169	151	320	17	2	19	26	20	46	320	339	366
4:45-5:00PM	16	1	3	0	160	160	320	17	3	20	26	30	56	320	340	376
5:00-5:15PM	6	0	7	0	156	199	355	6	7	13	9	70	79	355	368	434
5:15-5:30PM	35	3	12	0	238	288	526	38	12	50	58	120	178	526	576	704
5:30-5:45PM	15	0	20	0	217	156	373	15	20	35	23	200	223	373	408	596
5:45-6:00PM	15	0	8	0	239	197	436	15	8	23	23	80	103	436	459	539
Total	458	26	253	7	4525	4636	9161	484	260	744	736	2600	3336	9161	9905	12497

Bole Mikael (OP-3)											152m	OP-3	1000m	Day-2		
Pedestrian Counts	Counting Date-Tuesday (April 24/2018)															
Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	1.52L	10.0R	Sum (1.52L+10R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	11	1	9	0	189	196	385	12	9	21	18	90	108	385	406	493
8:15-8:30AM	17	1	11	0	164	191	355	18	11	29	27	110	137	355	384	492
8:30-8:45AM	16	0	15	1	158	156	314	16	16	32	24	160	184	314	346	498
8:45-9:00AM	16	2	14	0	173	184	357	18	14	32	27	140	167	357	389	524
9:00-9:15AM	19	0	19	1	158	175	333	19	20	39	29	200	229	333	372	562
9:15-9:30AM	13	0	18	2	129	112	241	13	20	33	20	200	220	241	274	461
9:30-9:45AM	15	1	20	0	134	105	239	16	20	36	24	200	224	239	275	463
9:45-10:00AM	16	2	8	1	128	135	263	18	9	27	27	90	117	263	290	380
10:00-10:15AM	20	0	6	0	126	127	253	20	6	26	30	60	90	253	279	343
10:15-10:30AM	22	1	11	0	143	146	289	23	11	34	35	110	145	289	323	434
10:30-10:45AM	17	0	13	0	112	128	240	17	13	30	26	130	156	240	270	396
10:45-11:00AM	17	1	14	2	122	120	242	18	16	34	27	160	187	242	276	429
11:00-11:15AM	21	0	8	0	112	124	236	21	8	29	32	80	112	236	265	348
11:15-11:30AM	17	2	13	0	123	112	235	19	13	32	29	130	159	235	267	394
11:30-11:45AM	13	1	12	0	86	91	177	14	12	26	21	120	141	177	203	318
11:45AM-12:00PM	14	1	8	1	89	136	225	15	9	24	23	90	113	225	249	338
2:00-2:15PM	16	2	11	0	80	79	159	18	11	29	27	110	137	159	188	296
2:15-2:30PM	15	1	7	0	131	100	231	16	7	23	24	70	94	231	254	325
2:30-2:45PM	16	0	10	0	112	87	199	16	10	26	24	100	124	199	225	323
2:45-3:00PM	18	0	7	1	98	88	186	18	8	26	27	80	107	186	212	293
3:00-3:15PM	14	0	8	0	109	108	217	14	8	22	21	80	101	217	239	318
3:15-3:30PM	14	2	8	1	109	151	260	16	9	25	24	90	114	260	285	374
3:30-3:45PM	22	6	9	2	140	133	273	28	11	39	43	110	153	273	312	426
3:45-4:00PM	25	2	14	0	201	257	458	27	14	41	41	140	181	458	499	639
4:00-4:15PM	19	0	15	0	178	157	335	19	15	34	29	150	179	335	369	514
4:15-4:30PM	12	2	9	3	109	161	270	14	12	26	21	120	141	270	296	411
4:30-4:45PM	21	0	8	0	163	142	305	21	8	29	32	80	112	305	334	417
4:45-5:00PM	22	0	6	0	158	162	320	22	6	28	33	60	93	320	348	413
5:00-5:15PM	15	0	17	0	164	204	368	15	17	32	23	170	193	368	400	561
5:15-5:30PM	28	4	17	1	238	273	511	32	18	50	49	180	229	511	561	740
5:30-5:45PM	16	3	14	0	216	160	376	19	14	33	29	140	169	376	409	545
5:45-6:00PM	15	1	8	0	150	206	356	16	8	24	24	80	104	356	380	460
Total	552	36	367	16	4502	4706	9208	588	383	971	894	3830	4724	9208	10179	13932

Bole Mikael (OP-3)											152m	OP-3	1000m	Day-3		
Pedestrian Counts	Counting Date-Thursday (April 26/2018)															
Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	1.52L	10.0R	Sum (1.52L+10R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	5	3	10	0	191	213	404	8	10	18	12	100	112	404	422	516
8:15-8:30AM	16	0	18	2	157	191	348	16	20	36	24	200	224	348	384	572
8:30-8:45AM	8	0	8	2	142	141	283	8	10	18	12	100	112	283	301	395
8:45-9:00AM	15	1	9	0	168	154	322	16	9	25	24	90	114	322	347	436
9:00-9:15AM	15	2	11	0	122	155	277	17	11	28	26	110	136	277	305	413
9:15-9:30AM	16	0	12	1	119	111	230	16	13	29	24	130	154	230	259	384
9:30-9:45AM	9	0	8	0	122	100	222	9	8	17	14	80	94	222	239	316
9:45-10:00AM	13	0	8	0	125	92	217	13	8	21	20	80	100	217	238	317
10:00-10:15AM	20	1	14	0	117	116	233	21	14	35	32	140	172	233	268	405
10:15-10:30AM	22	0	10	1	122	129	251	22	11	33	33	110	143	251	284	394
10:30-10:45AM	16	0	13	0	109	128	237	16	13	29	24	130	154	237	266	391
10:45-11:00AM	14	0	15	1	129	112	241	14	16	30	21	160	181	241	271	422
11:00-11:15AM	20	1	13	0	107	112	219	21	13	34	32	130	162	219	253	381
11:15-11:30AM	13	0	16	0	108	99	207	13	16	29	20	160	180	207	236	387
11:30-11:45AM	11	1	7	0	86	93	179	12	7	19	18	70	88	179	198	267
11:45AM-12:00PM	9	2	9	1	79	131	210	11	10	21	17	100	117	210	231	327
2:00-2:15PM	11	0	6	0	74	79	153	11	6	17	17	60	77	153	170	230
2:15-2:30PM	12	1	9	0	103	113	216	13	9	22	20	90	110	216	238	326
2:30-2:45PM	11	0	4	0	109	106	215	11	4	15	17	40	57	215	230	272
2:45-3:00PM	18	0	7	0	99	98	197	18	7	25	27	70	97	197	222	294
3:00-3:15PM	9	2	7	2	111	108	219	11	9	20	17	90	107	219	239	326
3:15-3:30PM	12	1	5	0	123	138	261	13	5	18	20	50	70	261	279	331
3:30-3:45PM	18	2	11	1	125	135	260	20	12	32	30	120	150	260	292	410
3:45-4:00PM	17	0	11	0	197	251	448	17	11	28	26	110	136	448	476	584
4:00-4:15PM	22	1	7	1	186	159	345	23	8	31	35	80	115	345	376	460
4:15-4:30PM	10	0	9	2	117	159	276	10	11	21	15	110	125	276	297	401
4:30-4:45PM	17	1	3	0	153	165	318	18	3	21	27	30	57	318	339	375
4:45-5:00PM	15	2	5	1	167	169	336	17	6	23	26	60	86	336	359	422
5:00-5:15PM	10	0	7	0	160	213	373	10	7	17	15	70	85	373	390	458
5:15-5:30PM	21	0	12	0	241	297	538	21	12	33	32	120	152	538	571	690
5:30-5:45PM	15	2	16	1	226	207	433	17	17	34	26	170	196	433	467	629
5:45-6:00PM	11	0	8	0	218	205	423	11	8	19	17	80	97	423	442	520
Total	451	23	308	16	4412	4679	9091	474	324	798	720	3240	3960	9091	9889	13051

St. Yosef Overpass (OP-4) | 1000m | OP-4 | 365m | Day-1

Pedestrian Counts — Counting Date-Friday (October 13/2017)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left & 100m Right)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	10.0L	3.65R	Sum(10.0L+3.65R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	3	0	4	0	115	176	291	3	4	7	30	15	45	291	298	336
8:15-8:30AM	4	0	6	0	109	135	244	4	6	10	40	22	62	244	254	306
8:30-8:45AM	2	0	7	0	99	106	205	2	7	9	20	26	46	205	214	251
8:45-9:00AM	2	0	6	0	85	120	205	2	6	8	20	22	42	205	213	247
9:00-9:15AM	5	0	3	2	79	87	166	5	5	10	50	18	68	166	176	234
9:15-9:30AM	1	0	5	0	81	76	157	1	5	6	10	18	28	157	163	185
9:30-9:45AM	2	0	4	0	57	68	125	2	4	6	20	15	35	125	131	160
9:45-10:00AM	5	0	5	0	88	87	175	5	5	10	50	18	68	175	185	243
10:00-10:15AM	1	0	6	0	72	79	151	1	6	7	10	22	32	151	158	183
10:15-10:30AM	4	0	4	0	61	73	134	4	4	8	40	15	55	134	142	189
10:30-10:45AM	2	0	5	0	78	69	147	2	5	7	20	18	38	147	154	185
10:45-11:00AM	1	0	9	2	65	63	128	1	11	12	10	40	50	128	140	178
11:00-11:15AM	1	0	1	1	70	58	128	1	2	3	10	7	17	128	131	145
11:15-11:30AM	5	0	6	0	63	56	119	5	6	11	50	22	72	119	130	191
11:30-11:45AM	4	0	4	1	67	68	135	4	5	9	40	18	58	135	144	193
11:45AM-12:00PM	1	0	1	0	75	89	164	1	1	2	10	4	14	164	166	178
2:00-2:15PM	3	0	1	0	71	72	143	3	1	4	30	4	34	143	147	177
2:15-2:30PM	5	0	2	0	79	87	166	5	2	7	50	7	57	166	173	223
2:30-2:45PM	2	0	2	0	66	119	185	2	2	4	20	7	27	185	189	212
2:45-3:00PM	3	0	1	1	80	68	148	3	2	5	30	7	37	148	153	185
3:00-3:15PM	4	0	10	2	70	112	182	4	12	16	40	44	84	182	198	266
3:15-3:30PM	4	0	2	2	101	117	218	4	4	8	40	15	55	218	226	273
3:30-3:45PM	8	0	4	0	162	213	375	8	4	12	80	15	95	375	387	470
3:45-4:00PM	11	3	9	0	207	242	449	14	9	23	140	33	173	449	472	622
4:00-4:15PM	5	2	9	4	113	153	266	7	13	20	70	47	117	266	286	383
4:15-4:30PM	7	0	5	1	102	120	222	7	6	13	70	22	92	222	235	314
4:30-4:45PM	5	1	2	0	203	215	418	6	2	8	60	7	67	418	426	485
4:45-5:00PM	5	3	1	4	138	166	304	8	5	13	80	18	98	304	317	402
5:00-5:15PM	8	0	2	0	153	140	293	8	2	10	80	7	87	293	303	380
5:15-5:30PM	5	0	9	0	134	149	283	5	9	14	50	33	83	283	297	366
5:30-5:45PM	3	0	2	0	116	150	266	3	2	5	30	7	37	266	271	303
5:45-6:00PM	6	0	9	0	153	117	270	6	9	15	60	33	93	270	285	363
Total	127	9	146	20	3212	3650	6862	136	166	302	1360	605.9	1966	6862	7164	8828

St. Yosef Overpass (OP-4) | 1000m | OP-4 | 365m | Day-2

Pedestrian Counts — Counting Date-Tuesday (April 24/2018)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left & 100m Right)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	10.0L	3.65R	Sum(10.0L+3.65R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	3	0	6	1	131	157	288	3	7	10	30	26	56	288	298	344
8:15-8:30AM	10	1	7	0	101	137	238	11	7	18	110	26	136	238	256	374
8:30-8:45AM	4	0	9	0	111	103	214	4	9	13	40	33	73	214	227	287
8:45-9:00AM	4	1	9	1	92	98	190	5	10	15	50	37	87	190	205	277
9:00-9:15AM	9	0	3	1	77	76	153	9	4	13	90	15	105	153	166	258
9:15-9:30AM	3	0	8	0	75	69	144	3	8	11	30	29	59	144	155	203
9:30-9:45AM	6	0	5	0	60	77	137	6	5	11	60	18	78	137	148	215
9:45-10:00AM	3	1	5	2	92	67	159	4	7	11	40	26	66	159	170	225
10:00-10:15AM	4	1	7	0	66	78	144	5	7	12	50	26	76	144	156	220
10:15-10:30AM	8	0	1	0	66	74	140	8	1	9	80	4	84	140	149	224
10:30-10:45AM	3	0	5	0	70	71	141	3	5	8	30	18	48	141	149	189
10:45-11:00AM	4	1	6	2	72	57	129	5	8	13	50	29	79	129	142	208
11:00-11:15AM	1	0	4	0	76	59	135	1	4	5	10	15	25	135	140	160
11:15-11:30AM	5	0	7	0	63	57	120	5	7	12	50	26	76	120	132	196
11:30-11:45AM	4	0	5	1	57	64	121	4	6	10	40	22	62	121	131	183
11:45AM-12:00PM	2	0	4	0	72	90	162	2	4	6	20	15	35	162	168	197
2:00-2:15PM	3	0	2	1	68	71	139	3	3	6	30	11	41	139	145	180
2:15-2:30PM	8	1	3	0	79	89	168	9	3	12	90	11	101	168	180	269
2:30-2:45PM	2	0	2	0	62	101	163	2	2	4	20	7	27	163	167	190
2:45-3:00PM	3	0	2	1	69	68	137	3	3	6	30	11	41	137	143	178
3:00-3:15PM	3	1	11	2	68	124	192	4	13	17	40	47	87	192	209	279
3:15-3:30PM	5	0	2	2	103	109	212	5	4	9	50	15	65	212	221	277
3:30-3:45PM	8	0	4	0	157	201	358	8	4	12	80	15	95	358	370	453
3:45-4:00PM	13	2	9	0	208	219	427	15	9	24	150	33	183	427	451	610
4:00-4:15PM	7	2	9	2	103	104	207	9	11	20	90	40	130	207	227	337
4:15-4:30PM	6	0	5	1	102	123	225	6	6	12	60	22	82	225	237	307
4:30-4:45PM	6	1	2	0	199	209	408	7	2	9	70	7	77	408	417	485
4:45-5:00PM	5	3	1	0	139	159	298	8	1	9	80	4	84	298	307	382
5:00-5:15PM	11	0	4	0	154	135	289	11	4	15	110	15	125	289	304	414
5:15-5:30PM	9	0	7	2	133	139	272	9	9	18	90	33	123	272	290	395
5:30-5:45PM	6	1	6	0	130	159	289	7	6	13	70	22	92	289	302	381
5:45-6:00PM	5	0	10	0	162	118	280	5	10	15	50	37	87	280	295	367
Total	173	16	170	19	3217	3462	6679	189	189	378	1890	689.85	2580	6679	7057	9259

St. Yosef Overpass (OP-4) | 1000m | OP-4 | 365m | Day-3

Pedestrian Counts — Counting Date-Monday (April 30/2018)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left & 100m Right)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	10.0L	3.65R	Sum(10.0L+3.65R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	10	2	2	0	123	168	291	12	2	14	120	7	127	291	305	418
8:15-8:30AM	6	0	13	1	115	136	251	6	14	20	60	51	111	251	271	362
8:30-8:45AM	8	1	3	0	126	81	207	9	3	12	90	11	101	207	219	308
8:45-9:00AM	3	0	5	1	97	122	219	3	6	9	30	22	52	219	228	271
9:00-9:15AM	5	0	6	0	88	80	168	5	6	11	50	22	72	168	179	240
9:15-9:30AM	1	1	8	0	83	74	157	2	8	10	20	29	49	157	167	206
9:30-9:45AM	8	0	5	1	66	61	127	8	6	14	80	22	102	127	141	229
9:45-10:00AM	4	0	9	0	75	81	156	4	9	13	40	33	73	156	169	229
10:00-10:15AM	7	0	8	0	76	80	156	7	8	15	70	29	99	156	171	255
10:15-10:30AM	4	0	6	0	63	71	134	4	6	10	40	22	62	134	144	196
10:30-10:45AM	6	1	6	0	82	65	147	7	6	13	70	22	92	147	160	239
10:45-11:00AM	3	0	10	2	66	58	124	3	12	15	30	44	74	124	139	198
11:00-11:15AM	9	1	4	1	65	61	126	10	5	15	100	18	118	126	141	244
11:15-11:30AM	7	0	6	0	57	58	115	7	6	13	70	22	92	115	128	207
11:30-11:45AM	2	0	7	1	71	59	130	2	8	10	20	29	49	130	140	179
11:45AM-12:00PM	5	0	2	0	81	70	151	5	2	7	50	7	57	151	158	208
2:00-2:15PM	2	1	9	0	69	74	143	3	9	12	30	33	63	143	155	206
2:15-2:30PM	4	0	3	0	89	65	154	4	3	7	40	11	51	154	161	205
2:30-2:45PM	5	0	8	0	73	99	172	5	8	13	50	29	79	172	185	251
2:45-3:00PM	6	1	5	1	72	78	150	7	6	13	70	22	92	150	163	242
3:00-3:15PM	8	0	7	1	80	116	196	8	8	16	80	29	109	196	212	305
3:15-3:30PM	8	1	5	0	124	98	222	9	5	14	90	18	108	222	236	330
3:30-3:45PM	12	0	7	2	152	218	370	12	9	21	120	33	153	370	391	523
3:45-4:00PM	16	0	11	1	217	239	456	16	12	28	160	44	204	456	484	660
4:00-4:15PM	11	1	11	3	118	148	266	12	14	26	120	51	171	266	292	437
4:15-4:30PM	8	2	8	0	132	110	242	10	8	18	100	29	129	242	260	371
4:30-4:45PM	12	1	4	0	200	203	403	13	4	17	130	15	145	403	420	548
4:45-5:00PM	9	0	6	2	142	158	300	9	8	17	90	29	119	300	317	419
5:00-5:15PM	15	1	8	0	164	143	307	16	8	24	160	29	189	307	331	496
5:15-5:30PM	9	0	9	0	142	144	286	9	9	18	90	33	123	286	304	409
5:30-5:45PM	10	0	7	0	134	146	280	10	7	17	100	26	126	280	297	406
5:45-6:00PM	13	2	11	0	138	129	267	15	11	26	150	40	190	267	293	457
Total	236	16	219	17	3380	3493	6873	252	236	488	2520	861.4	3381	6873	7361	10254

Saris Addisu Sefer (OP - 5) | 188m | OP-5 | 513m | Day-1

Pedestrian Counts | Counting Date-Monday (October 16/2017)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	1.88L	5.13R	Sum(1.88L+5.13R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	21	14	10	0	94	88	182	35	10	45	66	51	117	182	227	299
8:15-8:30AM	17	3	12	2	102	81	183	20	14	34	38	72	109	183	217	292
8:30-8:45AM	10	0	7	3	85	73	158	10	10	20	19	51	70	158	178	228
8:45-9:00AM	12	0	10	0	95	107	202	12	10	22	23	51	74	202	224	276
9:00-9:15AM	20	0	11	0	90	84	174	20	11	31	38	56	94	174	205	268
9:15-9:30AM	25	0	17	0	82	70	152	25	17	42	47	87	134	152	194	286
9:30-9:45AM	17	0	12	1	62	75	137	17	13	30	32	67	99	137	167	236
9:45-10:00AM	19	1	16	4	60	81	141	20	20	40	38	103	140	141	181	281
10:00-10:15AM	10	2	8	1	77	88	165	12	9	21	23	46	69	165	186	234
10:15-10:30AM	12	2	4	5	81	73	154	14	9	23	26	46	72	154	177	226
10:30-10:45AM	8	0	6	0	74	65	139	8	6	14	15	31	46	139	153	185
10:45-11:00AM	9	0	2	0	63	59	122	9	2	11	17	10	27	122	133	149
11:00-11:15AM	15	3	8	0	59	67	126	18	8	26	34	41	75	126	152	201
11:15-11:30AM	12	2	16	4	62	93	155	14	20	34	26	103	129	155	189	284
11:30-11:45AM	6	4	22	1	75	84	159	10	23	33	19	118	137	159	192	296
11:45AM-12:00PM	11	0	17	0	79	90	169	11	17	28	21	87	108	169	197	277
2:00-2:15PM	8	0	13	2	42	55	97	8	15	23	15	77	92	97	120	189
2:15-2:30PM	12	1	20	1	57	62	119	13	21	34	24	108	132	119	153	251
2:30-2:45PM	9	1	18	0	35	60	95	10	18	28	19	92	111	95	123	206
2:45-3:00PM	7	0	6	0	38	59	97	7	6	13	13	31	44	97	110	141
3:00-3:15PM	15	2	9	0	22	45	67	17	9	26	32	46	78	67	93	145
3:15-3:30PM	21	3	4	1	47	61	108	24	5	29	45	26	71	108	137	179
3:30-3:45PM	27	0	7	1	71	70	141	27	8	35	51	41	92	141	176	233
3:45-4:00PM	13	2	12	0	84	72	156	15	12	27	28	62	90	156	183	246
4:00-4:15PM	4	0	8	2	93	81	174	4	10	14	8	51	59	174	188	233
4:15-4:30PM	9	0	10	1	81	81	162	9	11	20	17	56	73	162	182	235
4:30-4:45PM	11	0	9	0	78	90	168	11	9	20	21	46	67	168	188	235
4:45-5:00PM	18	1	17	0	71	81	152	19	17	36	36	87	123	152	188	275
5:00-5:15PM	14	2	14	1	83	72	155	16	15	31	30	77	107	155	186	262
5:15-5:30PM	12	1	18	4	84	84	168	13	22	35	24	113	137	168	203	305
5:30-5:45PM	8	1	11	0	81	74	155	9	11	20	17	56	73	155	175	228
5:45-6:00PM	5	3	19	6	74	89	163	8	25	33	15	128	143	163	196	306
Total	417	48	373	40	2281	2414	4695	465	413	878	874	2118.7	2993	4695	5573	7688

Saris Addisu Sefer (OP - 5) | 188m | OP-5 | 513m | Day-2

Pedestrian Counts | Counting Date-Wednesday (April 25/2018)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	1.88L	5.13R	Sum(1.88L+5.13R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	19	16	13	1	92	85	177	35	14	49	66	72	138	177	226	315
8:15-8:30AM	18	3	11	2	102	82	184	21	13	34	39	67	106	184	218	290
8:30-8:45AM	16	0	7	2	81	78	159	16	9	25	30	46	76	159	184	235
8:45-9:00AM	12	2	10	0	95	108	203	14	10	24	26	51	78	203	227	281
9:00-9:15AM	20	0	11	3	91	86	177	20	14	34	38	72	109	177	211	286
9:15-9:30AM	26	4	17	0	83	64	147	30	17	47	56	87	144	147	194	291
9:30-9:45AM	19	0	11	1	68	72	140	19	12	31	36	62	97	140	171	237
9:45-10:00AM	21	1	13	3	60	81	141	22	16	38	41	82	123	141	179	264
10:00-10:15AM	8	2	8	1	77	89	166	10	9	19	19	46	65	166	185	231
10:15-10:30AM	8	2	6	5	80	70	150	10	11	21	19	56	75	150	171	225
10:30-10:45AM	7	0	8	1	73	66	139	7	9	16	13	46	59	139	155	198
10:45-11:00AM	9	0	2	0	64	53	117	9	2	11	17	10	27	117	128	144
11:00-11:15AM	14	2	8	1	62	70	132	16	9	25	30	46	76	132	157	208
11:15-11:30AM	15	1	16	5	62	93	155	16	21	37	30	108	138	155	192	293
11:30-11:45AM	10	4	19	2	75	80	155	14	21	35	26	108	134	155	190	289
11:45AM-12:00PM	10	0	11	2	83	92	175	10	13	23	19	67	85	175	198	260
2:00-2:15PM	13	0	9	2	45	52	97	13	11	24	24	56	81	97	121	178
2:15-2:30PM	10	1	19	1	63	55	118	11	20	31	21	103	123	118	149	241
2:30-2:45PM	9	1	18	0	36	59	95	10	18	28	19	92	111	95	123	206
2:45-3:00PM	9	0	9	2	42	59	101	9	11	20	17	56	73	101	121	174
3:00-3:15PM	16	2	9	0	30	42	72	18	9	27	34	46	80	72	99	152
3:15-3:30PM	23	3	9	2	45	63	108	26	11	37	49	56	105	108	145	213
3:30-3:45PM	25	0	7	0	72	70	142	25	7	32	47	36	83	142	174	225
3:45-4:00PM	15	1	18	0	75	71	146	16	18	34	30	92	122	146	180	268
4:00-4:15PM	7	2	14	1	95	82	177	9	15	24	17	77	94	177	201	271
4:15-4:30PM	8	0	15	2	75	79	154	8	17	25	15	87	102	154	179	256
4:30-4:45PM	17	1	8	0	79	91	170	18	8	26	34	41	75	170	196	245
4:45-5:00PM	17	1	18	1	73	82	155	18	19	37	34	97	131	155	192	286
5:00-5:15PM	16	2	16	0	84	73	157	18	16	34	34	82	116	157	191	273
5:15-5:30PM	10	0	20	4	80	88	168	10	24	34	19	123	142	168	202	310
5:30-5:45PM	13	0	16	0	80	70	150	13	16	29	24	82	107	150	179	257
5:45-6:00PM	11	1	13	3	83	91	174	12	16	28	23	82	105	174	202	279
Total	451	52	389	47	2305	2396	4701	503	436	939	946	2236.7	3182	4701	5640	7883

Saris Addisu Sefer (OP - 5) | 188m | OP-5 | 513m | Day-3

Pedestrian Counts | Counting Date-Monday (April 30/2018)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	1.88L	5.13R	Sum(1.88L+5.13R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	27	11	13	3	87	103	190	38	16	54	71	82	154	190	244	344
8:15-8:30AM	18	0	15	5	90	111	201	18	20	38	34	103	136	201	239	337
8:30-8:45AM	15	1	7	3	86	84	170	16	10	26	30	51	81	170	196	251
8:45-9:00AM	16	0	6	4	104	99	203	16	10	26	30	51	81	203	229	284
9:00-9:15AM	16	2	11	0	96	87	183	18	11	29	34	56	90	183	212	273
9:15-9:30AM	19	0	22	2	82	85	167	19	24	43	36	123	159	167	210	326
9:30-9:45AM	20	1	16	0	76	61	137	21	16	37	39	82	122	137	174	259
9:45-10:00AM	20	0	17	3	75	77	152	20	20	40	38	103	140	152	192	292
10:00-10:15AM	6	2	13	1	83	70	153	8	14	22	15	72	87	153	175	240
10:15-10:30AM	9	3	12	0	80	77	157	12	12	24	23	62	84	157	181	241
10:30-10:45AM	9	0	4	1	69	78	147	9	5	14	17	26	43	147	161	190
10:45-11:00AM	7	0	3	0	71	55	126	7	3	10	13	15	29	126	136	155
11:00-11:15AM	11	3	14	1	59	68	127	14	15	29	26	77	103	127	156	230
11:15-11:30AM	13	2	10	0	71	93	164	15	10	25	28	51	80	164	189	244
11:30-11:45AM	6	0	13	1	63	91	154	6	14	20	11	72	83	154	174	237
11:45AM-12:00PM	11	4	19	0	88	93	181	15	19	34	28	97	126	181	215	307
2:00-2:15PM	14	3	13	0	58	61	119	17	13	30	32	67	99	119	149	218
2:15-2:30PM	11	4	16	0	66	59	125	15	16	31	28	82	110	125	156	235
2:30-2:45PM	13	0	19	1	40	61	101	13	20	33	24	103	127	101	134	228
2:45-3:00PM	7	2	9	0	37	59	96	9	9	18	17	46	63	96	114	159
3:00-3:15PM	16	0	12	0	35	46	81	16	12	28	30	62	92	81	109	173
3:15-3:30PM	19	2	6	0	55	59	114	21	6	27	39	31	70	114	141	184
3:30-3:45PM	22	0	15	2	75	69	144	22	17	39	41	87	129	144	183	273
3:45-4:00PM	10	0	17	3	80	67	147	10	20	30	19	103	121	147	177	268
4:00-4:15PM	8	3	11	0	90	79	169	11	11	22	21	56	77	169	191	246
4:15-4:30PM	11	0	9	0	93	72	165	11	9	20	21	46	67	165	185	232
4:30-4:45PM	7	0	7	2	79	87	166	7	9	16	13	46	59	166	182	225
4:45-5:00PM	17	3	15	0	83	74	157	20	15	35	38	77	115	157	192	272
5:00-5:15PM	10	0	14	3	82	73	155	10	17	27	19	87	106	155	182	261
5:15-5:30PM	12	0	19	3	89	77	166	12	22	34	23	113	135	166	200	301
5:30-5:45PM	15	0	8	2	79	70	149	15	10	25	28	51	80	149	174	229
5:45-6:00PM	11	0	18	3	88	96	184	11	21	32	21	108	128	184	216	312
Total	426	46	403	43	2409	2441	4850	472	446	918	887	2288	3175	4850	5768	8025

Ersha Sebil (OP - 6) | 513m | OP-6 | 345m | Day-1

Pedestrian Counts — Counting Date-Tuesday (October 17/2017)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	5.13L	3.45R	Sum(5.13L+3.45R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	1	0	2	0	67	105	172	1	2	3	5	7	12	172	175	184
8:15-8:30AM	0	0	0	0	47	93	140	0	0	0	0	0	0	140	140	140
8:30-8:45AM	5	0	1	0	19	33	52	5	1	6	26	3	29	52	58	81
8:45-9:00AM	1	0	2	0	13	30	43	1	2	3	5	7	12	43	46	55
9:00-9:15AM	2	0	2	0	27	10	37	2	2	4	10	7	17	37	41	54
9:15-9:30AM	0	0	1	0	22	18	40	0	1	1	0	3	3	40	41	43
9:30-9:45AM	6	1	11	0	39	53	92	7	11	18	36	38	74	92	110	166
9:45-10:00AM	1	0	2	0	19	25	44	1	2	3	5	7	12	44	47	56
10:00-10:15AM	0	0	1	1	17	27	44	0	2	2	0	7	7	44	46	51
10:15-10:30AM	3	0	0	0	11	28	39	3	0	3	15	0	15	39	42	54
10:30-10:45AM	0	0	4	0	18	32	50	0	4	4	0	14	14	50	54	64
10:45-11:00AM	0	0	3	1	32	25	57	0	4	4	0	14	14	57	61	71
11:00-11:15AM	0	0	0	1	15	33	48	0	1	1	0	3	3	48	49	51
11:15-11:30AM	1	0	3	0	26	28	54	1	3	4	5	10	15	54	58	69
11:30-11:45AM	3	0	1	0	25	28	53	3	1	4	15	3	19	53	57	72
11:45AM-12:00PM	4	2	1	0	20	24	44	6	1	7	31	3	34	44	51	78
2:00-2:15PM	2	0	2	0	31	29	60	2	2	4	10	7	17	60	64	77
2:15-2:30PM	0	0	0	0	23	41	64	0	0	0	0	0	0	64	64	64
2:30-2:45PM	4	1	7	0	59	60	119	5	7	12	26	24	50	119	131	169
2:45-3:00PM	3	0	4	0	67	83	150	3	4	7	15	14	29	150	157	179
3:00-3:15PM	7	2	5	0	41	58	99	9	5	14	46	17	63	99	113	162
3:15-3:30PM	2	0	3	1	33	37	70	2	4	6	10	14	24	70	76	94
3:30-3:45PM	2	0	0	0	39	45	84	2	0	2	10	0	10	84	86	94
3:45-4:00PM	3	0	0	0	33	29	62	3	0	3	15	0	15	62	65	77
4:00-4:15PM	2	1	1	0	30	35	65	3	1	4	15	3	19	65	69	84
4:15-4:30PM	2	0	2	0	27	31	58	2	2	4	10	7	17	58	62	75
4:30-4:45PM	3	1	0	0	30	22	52	4	0	4	21	0	21	52	56	73
4:45-5:00PM	0	0	1	0	43	24	67	0	1	1	0	3	3	67	68	70
5:00-5:15PM	5	2	2	2	51	44	95	7	4	11	36	14	50	95	106	145
5:15-5:30PM	8	0	2	0	51	67	118	8	2	10	41	7	48	118	128	166
5:30-5:45PM	1	0	3	0	49	71	120	1	3	4	5	10	15	120	124	135
5:45-6:00PM	4	3	2	0	50	60	110	7	2	9	36	7	43	110	119	153
Total	75	13	68	6	1074	1328	2402	88	74	162	451	255.3	707	2402	2564	3109

Ersha Sebil (OP - 6) | 513m | OP-6 | 345m | Day-2

Pedestrian Counts — Counting Date-Wednesday (April 25/2018)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	5.13L	3.45R	Sum(5.13L+3.45R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	2	0	1	1	42	78	120	2	2	4	10	7	17	120	124	137
8:15-8:30AM	1	0	1	0	78	113	191	1	1	2	5	3	9	191	193	200
8:30-8:45AM	6	0	2	1	70	78	148	6	3	9	31	10	41	148	157	189
8:45-9:00AM	1	0	2	0	25	30	55	1	2	3	5	7	12	55	58	67
9:00-9:15AM	2	0	2	0	16	20	36	2	2	4	10	7	17	36	40	53
9:15-9:30AM	0	0	1	0	24	19	43	0	1	1	0	3	3	43	44	46
9:30-9:45AM	2	1	4	0	49	41	90	3	4	7	15	14	29	90	97	119
9:45-10:00AM	2	0	2	0	12	27	39	2	2	4	10	7	17	39	43	56
10:00-10:15AM	4	0	1	1	16	27	43	4	2	6	21	7	27	43	49	70
10:15-10:30AM	0	0	2	0	11	31	42	0	2	2	0	7	7	42	44	49
10:30-10:45AM	0	0	4	0	17	15	32	0	4	4	0	14	14	32	36	46
10:45-11:00AM	1	1	2	1	33	19	52	2	3	5	10	10	21	52	57	73
11:00-11:15AM	0	0	0	1	21	19	40	0	1	1	0	3	3	40	41	43
11:15-11:30AM	3	0	2	0	32	21	53	3	2	5	15	7	22	53	58	75
11:30-11:45AM	3	0	1	0	36	28	64	3	1	4	15	3	19	64	68	83
11:45AM-12:00PM	3	0	1	1	20	33	53	3	2	5	15	7	22	53	58	75
2:00-2:15PM	1	0	0	0	30	25	55	1	0	1	5	0	5	55	56	60
2:15-2:30PM	0	0	0	0	19	40	59	0	0	0	0	0	0	59	59	59
2:30-2:45PM	6	1	3	1	51	32	83	7	4	11	36	14	50	83	94	133
2:45-3:00PM	1	0	1	0	64	39	103	1	1	2	5	3	9	103	105	112
3:00-3:15PM	9	2	5	0	43	48	91	11	5	16	56	17	74	91	107	165
3:15-3:30PM	2	0	3	1	47	30	77	2	4	6	10	14	24	77	83	101
3:30-3:45PM	2	0	0	0	34	44	78	2	0	2	10	0	10	78	80	88
3:45-4:00PM	3	0	0	0	36	29	60	3	0	3	15	0	15	60	63	75
4:00-4:15PM	4	1	1	0	29	35	64	5	1	6	26	3	29	64	70	93
4:15-4:30PM	3	0	2	0	28	33	61	3	2	5	15	7	22	61	66	83
4:30-4:45PM	8	1	2	0	31	25	56	9	2	11	46	7	53	56	67	109
4:45-5:00PM	6	0	3	0	45	28	73	6	3	9	31	10	41	73	82	114
5:00-5:15PM	5	2	2	2	52	39	91	7	4	11	36	14	50	91	102	141
5:15-5:30PM	8	0	2	0	75	52	127	8	2	10	41	7	48	127	137	175
5:30-5:45PM	5	0	3	0	54	58	112	5	3	8	26	10	36	112	120	148
5:45-6:00PM	6	1	3	1	45	62	107	7	4	11	36	14	50	107	118	157
Total	99	10	58	11	1185	1218	2398	109	69	178	559	238.05	797	2398	2576	3195

Ersha Sebil (OP - 6) | 513m | OP-6 | 345m | Day-3

Pedestrian Counts — Counting Date-Monday (April 30/2018)

Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	5.13L	3.45R	Sum(5.13L+3.45R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	10	1	4	0	93	79	172	11	4	15	56	14	70	172	187	242
8:15-8:30AM	4	0	6	2	68	72	140	4	8	12	21	28	48	140	152	188
8:30-8:45AM	11	2	7	0	41	29	70	13	7	20	67	24	91	70	90	161
8:45-9:00AM	6	2	1	0	20	25	45	8	1	9	41	3	44	45	54	89
9:00-9:15AM	3	1	5	1	26	13	39	4	6	10	21	21	41	39	49	80
9:15-9:30AM	5	0	3	0	32	21	53	5	3	8	26	10	36	53	61	89
9:30-9:45AM	0	2	11	1	46	39	85	2	12	14	10	41	52	85	99	137
9:45-10:00AM	3	1	4	0	20	29	49	4	4	8	21	14	34	49	57	83
10:00-10:15AM	8	0	5	1	15	30	45	8	6	14	41	21	62	45	59	107
10:15-10:30AM	2	2	6	0	19	31	50	4	6	10	21	21	41	50	60	91
10:30-10:45AM	3	0	6	0	21	33	54	3	6	9	15	21	36	54	63	90
10:45-11:00AM	7	2	3	0	29	21	50	9	3	12	46	10	57	50	62	107
11:00-11:15AM	6	1	4	0	33	31	64	7	4	11	36	14	50	64	75	114
11:15-11:30AM	4	0	2	2	25	33	58	4	4	8	21	14	34	58	66	92
11:30-11:45AM	2	0	1	0	31	25	56	2	1	3	10	3	14	56	59	70
11:45AM-12:00PM	7	1	6	0	32	27	59	8	6	14	41	21	62	59	73	121
2:00-2:15PM	4	2	3	0	40	31	71	6	3	9	31	10	41	71	80	112
2:15-2:30PM	3	0	3	2	31	42	73	3	5	8	15	17	33	73	81	106
2:30-2:45PM	3	4	7	0	63	71	134	7	7	14	36	24	60	134	148	194
2:45-3:00PM	5	0	3	0	67	70	137	5	3	8	26	10	36	137	145	173
3:00-3:15PM	5	0	6	0	39	66	105	5	6	11	26	21	46	105	116	151
3:15-3:30PM	7	0	3	2	36	42	78	7	5	12	36	17	53	78	90	131
3:30-3:45PM	6	1	0	0	42	47	89	7	0	7	36	0	36	89	96	125
3:45-4:00PM	1	0	7	0	38	33	71	1	7	8	5	24	29	71	79	100
4:00-4:15PM	5	0	5	0	36	42	78	5	5	10	26	17	43	78	88	121
4:15-4:30PM	6	2	3	0	37	42	79	8	3	11	41	10	51	79	90	130
4:30-4:45PM	10	0	11	1	41	29	70	10	12	22	51	41	93	70	92	163
4:45-5:00PM	8	0	7	0	51	33	84	8	7	15	41	24	65	84	99	149
5:00-5:15PM	5	0	10	1	61	44	105	5	11	16	26	38	64	105	121	169
5:15-5:30PM	9	2	5	0	51	55	106	11	5	16	56	17	74	106	122	180
5:30-5:45PM	9	0	6	2	56	68	124	9	8	17	46	28	74	124	141	198
5:45-6:00PM	9	0	6	2	47	66	113	9	8	17	46	28	74	113	130	187
Total	176	26	159	17	1287	1319	2606	202	176	378	1036	607.2	1643	2606	2984	4249

Hana Mariam (OP - 7)											590m	OP-7	560m	Day-1		
Pedestrian Counts	Counting Date-Thursday (Oct. 19/2017)															
Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	5.9L	5.6R	Sum(5.9L+5.6R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	3	0	4	0	35	21	56	3	4	7	18	22	40	56	63	96
8:15-8:30AM	2	0	1	0	21	17	38	2	1	3	12	6	17	38	41	55
8:30-8:45AM	0	0	3	0	19	20	39	0	3	3	0	17	17	39	42	56
8:45-9:00AM	1	0	3	1	25	17	42	1	4	5	6	22	28	42	47	70
9:00-9:15AM	2	0	0	0	21	8	29	2	0	2	12	0	12	29	31	41
9:15-9:30AM	4	1	0	0	10	2	12	5	0	5	30	0	30	12	17	42
9:30-9:45AM	1	0	0	0	12	4	16	1	0	1	6	0	6	16	17	22
9:45-10:00AM	2	0	1	0	6	9	15	2	1	3	12	6	17	15	18	32
10:00-10:15AM	0	0	0	0	7	7	14	0	0	0	0	0	0	14	14	14
10:15-10:30AM	0	0	2	0	7	4	11	0	2	2	0	11	11	11	13	22
10:30-10:45AM	0	0	1	0	7	5	12	0	1	1	0	6	6	12	13	18
10:45-11:00AM	0	0	1	0	6	5	11	0	1	1	0	6	6	11	12	17
11:00-11:15AM	3	0	1	0	4	7	11	3	1	4	18	6	23	11	15	34
11:15-11:30AM	0	0	1	0	6	3	9	0	1	1	0	6	6	9	10	15
11:30-11:45AM	0	0	0	0	5	3	8	0	0	0	0	0	0	8	8	8
11:45AM-12:00PM	0	0	0	0	7	5	12	0	0	0	0	0	0	12	12	12
2:00-2:15PM	1	0	0	0	3	1	4	1	0	1	6	0	6	4	5	10
2:15-2:30PM	3	0	0	0	11	5	16	3	0	3	18	0	18	16	19	34
2:30-2:45PM	8	0	1	0	7	7	14	8	1	9	47	6	53	14	23	67
2:45-3:00PM	1	0	0	1	12	9	21	1	1	2	6	6	12	21	23	33
3:00-3:15PM	3	1	0	0	5	6	11	4	0	4	24	0	24	11	15	35
3:15-3:30PM	4	0	1	1	7	19	26	4	2	6	24	11	35	26	32	61
3:30-3:45PM	1	1	1	0	12	15	27	2	1	3	12	6	17	27	30	44
3:45-4:00PM	1	0	0	0	8	14	22	1	0	1	6	0	6	22	23	28
4:00-4:15PM	8	1	0	0	6	11	17	9	0	9	53	0	53	17	26	70
4:15-4:30PM	7	2	0	0	14	18	32	9	0	9	53	0	53	32	41	85
4:30-4:45PM	6	0	3	0	26	36	62	6	3	9	35	17	52	62	71	114
4:45-5:00PM	5	1	0	0	27	42	69	6	0	6	35	0	35	69	75	104
5:00-5:15PM	10	8	3	1	22	21	43	18	4	22	106	22	129	43	65	172
5:15-5:30PM	5	1	1	0	24	15	39	6	1	7	35	6	41	39	46	80
5:30-5:45PM	3	0	2	1	19	25	44	3	3	6	18	17	35	44	50	79
5:45-6:00PM	0	1	1	0	27	24	51	1	1	2	6	6	12	51	53	63
Total	84	17	31	5	428	405	833	101	36	137	596	201.6	798	833	970	1631

Hana Mariam (OP - 7)											590m	OP-7	560m	Day-2		
Pedestrian Counts	Counting Date-Wednesday (April 25/2018)															
Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	5.9L	5.6R	Sum(5.9L+5.6R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	7	1	6	0	36	32	68	8	6	14	47	34	81	68	82	149
8:15-8:30AM	3	0	1	0	19	16	35	3	1	4	18	6	23	35	39	58
8:30-8:45AM	1	0	3	1	21	19	40	1	4	5	6	22	28	40	45	68
8:45-9:00AM	1	0	3	1	25	17	42	1	4	5	6	22	28	42	47	70
9:00-9:15AM	2	0	0	0	20	9	29	2	0	2	12	0	12	29	31	41
9:15-9:30AM	0	1	3	0	8	3	11	1	3	4	6	17	23	11	15	34
9:30-9:45AM	1	0	0	0	6	5	11	1	0	1	6	0	6	11	12	17
9:45-10:00AM	2	0	1	1	11	7	18	2	2	4	12	11	23	18	22	41
10:00-10:15AM	2	0	0	0	9	6	15	2	0	2	12	0	12	15	17	27
10:15-10:30AM	0	1	2	0	4	5	9	1	2	3	6	11	17	9	12	26
10:30-10:45AM	0	0	3	1	5	4	9	0	4	4	0	22	22	9	13	31
10:45-11:00AM	0	0	1	0	3	7	10	0	1	1	0	6	6	10	11	16
11:00-11:15AM	3	0	1	0	4	6	10	3	1	4	18	6	23	10	14	33
11:15-11:30AM	0	0	1	0	4	4	8	0	1	1	0	6	6	8	9	14
11:30-11:45AM	0	0	0	0	3	3	6	0	0	0	0	0	0	6	6	6
11:45AM-12:00PM	2	0	1	0	8	5	13	2	1	3	12	6	17	13	16	30
2:00-2:15PM	1	1	0	0	3	2	5	2	0	2	12	0	12	5	7	17
2:15-2:30PM	3	0	2	0	9	5	14	3	2	5	18	11	29	14	19	43
2:30-2:45PM	8	0	1	1	7	8	15	8	2	10	47	11	58	15	25	73
2:45-3:00PM	1	0	0	1	14	9	23	1	1	2	6	6	12	23	25	35
3:00-3:15PM	3	1	0	0	5	10	15	4	0	4	24	0	24	15	19	39
3:15-3:30PM	3	0	1	1	8	17	25	3	2	5	18	11	29	25	30	54
3:30-3:45PM	1	1	1	0	9	16	25	2	1	3	12	6	17	25	28	42
3:45-4:00PM	0	0	0	0	9	10	19	0	0	0	0	0	0	19	19	19
4:00-4:15PM	3	1	0	0	8	10	18	4	0	4	24	0	24	18	22	42
4:15-4:30PM	10	2	0	0	16	14	30	12	0	12	71	0	71	30	42	101
4:30-4:45PM	6	0	3	0	23	31	54	6	3	9	35	17	52	54	63	106
4:45-5:00PM	5	1	0	0	24	39	63	6	0	6	35	0	35	63	69	98
5:00-5:15PM	10	8	3	1	21	21	42	18	4	22	106	22	129	42	64	171
5:15-5:30PM	4	1	1	0	24	15	39	5	1	6	30	6	35	39	45	74
5:30-5:45PM	4	0	2	1	25	20	45	4	3	7	24	17	40	45	52	85
5:45-6:00PM	1	1	2	0	31	20	51	2	2	4	12	11	23	51	55	74
Total	87	20	42	9	422	395	817	107	51	158	631	285.6	917	817	975	1734

Hana Mariam (OP - 7)											590m	OP-7	560m	Day-3		
Pedestrian Counts	Counting Date-Friday (April 27/2018)															
Time Intervals	Left (100m)		Right (100m)		On the pedestrian overpass			Total non-users (100m Left and 100m R)			Diverted pedestrians (Non-users) up to half distance of nxt threatment			V15 minutes count		
	M	F	M	F	M	F	Total	L	R	Sum (L+R)	5.9L	5.6R	Sum(5.9L+5.6R)	Users Only	Users + Diverted (200m)	Users + Diverted (Up to Half Ditance)
8:00-8:15AM	5	0	6	0	38	22	60	5	6	11	30	34	63	60	71	123
8:15-8:30AM	3	1	1	0	20	19	39	4	1	5	24	6	29	39	44	68
8:30-8:45AM	3	0	2	0	22	14	36	3	2	5	18	11	29	36	41	65
8:45-9:00AM	4	1	1	0	24	15	39	5	1	6	30	6	35	39	45	74
9:00-9:15AM	2	0	2	1	19	11	30	2	3	5	12	17	29	30	35	59
9:15-9:30AM	3	0	0	0	10	6	16	3	0	3	18	0	18	16	19	34
9:30-9:45AM	0	0	0	1	13	7	20	0	1	1	0	6	6	20	21	26
9:45-10:00AM	3	0	2	0	10	5	15	3	2	5	18	11	29	15	20	44
10:00-10:15AM	3	0	1	1	8	6	14	3	2	5	18	11	29	14	19	43
10:15-10:30AM	1	1	1	0	6	5	11	2	1	3	12	6	17	11	14	28
10:30-10:45AM	0	0	2	0	9	7	16	0	2	2	0	11	11	16	18	27
10:45-11:00AM	0	0	0	0	10	3	13	0	0	0	0	0	0	13	13	13
11:00-11:15AM	2	0	2	0	7	6	13	2	2	4	12	11	23	13	17	36
11:15-11:30AM	2	1	1	1	6	2	8	3	2	5	18	11	29	8	13	37
11:30-11:45AM	0	0	1	0	6	4	10	0	1	1	0	6	6	10	11	16
11:45AM-12:00PM	2	0	2	1	10	6	16	2	3	5	12	17	29	16	21	45
2:00-2:15PM	3	0	2	0	9	4	13	3	2	5	18	11	29	13	18	42
2:15-2:30PM	3	0	2	1	8	6	14	3	3	6	18	17	35	14	20	49
2:30-2:45PM	7	0	0	0	7	8	15	7	0	7	41	0	41	15	22	56
2:45-3:00PM	4	1	0	0	13	7	20	5	0	5	30	0	30	20	25	50
3:00-3:15PM	3	0	2	1	4	6	10	3	3	6	18	17	35	10	16	45
3:15-3:30PM	3	0	1	0	12	13	25	3	1	4	18	6	23	25	29	48
3:30-3:45PM	1	1	2	0	9	15	24	2	2	4	12	11	23	24	28	47
3:45-4:00PM	4	0	1	0	13	11	24	4	1	5	24	6	29	24	29	53
4:00-4:15PM	5	0	2	1	12	9	21	5	3	8	30	17	46	21	29	67
4:15-4:30PM	7	0	2	0	19	21	40	7	2	9	41	11	53	40	49	93
4:30-4:45PM	0	0	3	0	26	36	62	0	3	3	0	17	17	62	65	79
4:45-5:00PM	4	0	1	0	32	37	69	4	1	5	24	6	29	69	74	98
5:00-5:15PM	7	1	3	1	31	19	50	8	4	12	47	22	70	50	62	120
5:15-5:30PM	6	0	1	0	30	21	51	6	1	7	35	6	41	51	58	92
5:30-5:45PM	4	1	2	1	24	27	51	5	3	8	30	17	46	51	59	97
5:45-6:00PM	5	1	4	0	31	25	56	6	4	10	35	22	58	56	66	114
Total	99	9	52	10	498	403	901	108	62	170	637	347.2	984	901	1071	1885

Table A.4: Miscellaneous Data of Pedestrian Overpasses along the Addis Ababa Ring Road

Overpasses	Clear Height (m)	Length (m)			Width (m)		Railing Height (m)	Thread Height (cm)	Number of Stairway Flights	Number of steps on the stairway	Number of Traffic Flow Directions	Posted Speed Limit Below the Facility (km/hr)	
		Slab/ Deck	Stair	Overall Length	Face to face of Handrail	Effective Width						Inner Carriageway	Outer Carriage way
Nyala (OP-1)	5.4	42.4	2x45.3	133	2.75	2.5	1.10	10	4	45	4	80	50
Hayat (OP-2)	5.4	42.4	2x45.3	133	2.75	2.5	1.10	10	4	44	4	80	50
Bole (OP-3)	5.4	42.4	2x45.3	133	2.75	2.5	1.10	10	4	45	4	80	50
Yoseph(OP-4)	5.4	42.4	2x45.3	133	2.75	2.5	1.10	10	4	44	4	80	50
Saris (OP-5)	5.4	42.4	2x45.3	133	2.75	2.5	1.10	10	4	46	4	80	50
Ersha (OP-6)	5.4	42.4	2x45.3	133	2.75	2.5	1.10	10	4	44	4	80	50
Hana (OP-7)	5.4	42.4	2x45.3	133	2.75	2.5	1.10	10	4	45	4	80	50

Table A.5: Time Took by Pedestrians to Cross the Ring Road Using Overpasses (in Seconds)

Label	P_{1u}	P_{2u}	P_{3u}	P_{4u}	P_{5u}	P_{6u}	P_{7u}	P_{8u}	P_{9u}	P_{10u}	P_{11u}	P_{12u}	P_{13u}
Nyala Motors (OP-1)	110	100	105	142	90	111	108	330	90	123	97	127	97
Hayat Hospital (OP-2)	114	128	112	118	93	112	82	133	71	108	131	107	80
Bole Mikael (OP-3)	136	120	127	130	118	175	121	119	83	130	124	121	107
St Yoseph Church (OP-4)	147	117	129	134	107	148	111	100	102	174	112	122	94
Saris Addisu S. (OP-5)	95	105	118	150	133	135	94	115	121	116	125	102	97
Ersha Sebil (OP-6)	156	96	160	139	118	102	148	112	120	113	113	100	94
Hana Mariam (OP-7)	97	82	127	128	130	101	112	128	131	142	176	96	67

P_{14u}	P_{15u}	P_{16u}	P_{17u}	P_{18u}	P_{19u}	P_{20u}	P_{21u}	P_{22u}	P_{23u}	P_{24u}	P_{25u}	P_{26u}	P_{27u}	P_{28u}	P_{29u}
95	102	113	84	100	162	147	142	96	107	117	97	100	109	125	118
142	95	105	125	110	120	129	112	130	113	113	117	115	89	110	104
96	111	124	93	121	161	94	120	126	96	101	152	127	145	163	114
154	102	112	88	127	113	116	105	96	129	107	109	134	102	119	96
85	99	105	102	83	111	94	107	119	128	120	102	103	122	91	93
110	90	120	171	125	95	97	102	127	100	96	87	103	151	112	150
95	98	129	110	129	128	112	165	106	77	120	119	117	128	138	114

P_{30u}	P_{31u}	P_{32u}	P_{33u}	P_{34u}	P_{35u}	P_{36u}	P_{37u}	P_{38u}	P_{39u}	P_{40u}	Minimum	Maximum	Average
90	105	110	115	102	134	116	116	101	127	87	84	330	116.18
109	100	81	90	101	112	97	119	135	97	93	71	142	108.80
117	131	98	120	143	99	126	111	132	145	153	83	175	123.25
109	120	95	117	98	111	89	147	114	123	89	88	174	115.45
86	95	112	115	118	95	174	133	128	119	98	83	174	111.08
82	163	136	139	132	153	103	93	116	98	135	82	171	118.93
117	100	116	110	77	80	96	108	101	138	97	67	176	113.55

Table A.6: Time Took by Pedestrians to Cross the Ring Road without Using Overpasses (in Seconds)

First 25m in both sides (0-25m)										
Label	P_{1w}	P_{2w}	P_{3w}	P_{4w}	P_{5w}	P_{6w}	P_{7w}	P_{8w}	P_{9w}	P_{10w}
Nyala Motors(OP-1)	51	44	80	43	50	55	42	36	65	31
Hayat Hospital(OP-2)	46	57	60	58	76	65	48	62	34	56
Bole Mikael(OP-3)	55	61	51	34	68	66	36	40	25	46
St Yoseph Church(OP-4)	106	60	57	68	84	69	93	51	71	75
Saris Addisu Sefer(OP-5)	92	31	46	80	33	90	77	33	39	38
Ersha Sebil(OP-6)	32	66	41	58	77	48	39	58	77	68
Hana Mariam(OP-7)	50	41	34	45	41	68	57	47	35	38

Second 25m in both sides (25-50m)									
P_{11w}	P_{12w}	P_{13w}	P_{14w}	P_{15w}	P_{16w}	P_{17w}	P_{18w}	P_{19w}	P_{20w}
43	74	26	35	53	80	28	41	65	59
45	56	32	35	95	57	90	22	40	32
114	64	62	59	43	57	40	112	40	54
103	48	90	61	51	61	50	65	83	67
70	37	38	66	48	90	53	42	70	38
49	92	39	78	30	45	92	68	50	86
41	42	34	33	68	36	37	62	34	39

Third 25m in both sides(50-75m)									
P_{21w}	P_{22w}	P_{23w}	P_{24w}	P_{25w}	P_{26w}	P_{27w}	P_{28w}	P_{29w}	P_{30w}
69	29	46	51	76	67	29	30	58	48
58	55	60	48	37	38	53	76	31	39
40	34	36	40	41	31	105	73	90	97
94	54	80	38	120	46	76	63	59	60
60	38	92	45	44	51	71	30	40	46
100	79	58	29	90	86	22	90	43	58
38	40	36	47	31	52	27	31	46	66

Fourth 25m in both sides(50-75m)										Minimum	Maximum	Average
P_{31w}	P_{32w}	P_{33w}	P_{34w}	P_{35w}	P_{36w}	P_{37w}	P_{38w}	P_{39w}	P_{40w}			
75	56	37	40	98	80	51	58	55	46	26	98	52.50
34	44	79	52	87	37	85	50	89	51	22	95	54.23
100	73	48	84	53	80	89	40	46	38	25	114	59.13
65	109	68	46	80	66	72	110	80	69	38	120	71.70
42	66	45	60	46	42	46	60	30	62	30	92	53.18
66	78	52	40	57	80	82	42	45	42	22	100	60.80
81	37	48	100	34	101	42	50	38	61	27	101	47.20

Appendix-B: Questionnaire Format for Pedestrians

Confidential Clause

My name is Tilahun Haile. I am currently carrying out thesis research titled "***Assessment of Pedestrian Overpass Facilities along the Addis Ababa Ring Road***" as a partial fulfillment of MSc degree in Road and Transport Engineering at Addis Ababa Institute of Technology, school of Civil and Environmental Engineering. To successfully conduct this research, it is mandatory to look into the issues from different perspectives by involving pedestrians. In this respect, you are the one who can give the correct information; hence I kindly request you to respond to the questionnaire. Please be informed that your responses will be safeguarded with strict confidentiality and used for this research purposes only. I would like to express my heartfelt appreciation in advance for your cooperation and sparing some of your precious time.

Instruction: Please ***Tick*** (✓) in the space provided. Feel free to tick on more than one alternative, and it is also possible to write your opinion on the spaces provided.

Overpass Location____________	Date____________	Day of the week_________
Type of Pedestrian Surveyed	Overpass user ☐	Overpass non-user ☐

1. Gender

Male ☐ Female ☐

2. Age

Less than 18 ☐ 18-30 ☐ 31-50 ☐ More than 50 ☐

3. What is your marital status?

Single ☐ Married ☐ Others (Divorced, Widowed) ☐

4. Educational level

☐ Primary school (Grade 1-8)

☐ First cycle secondary school (Grade 9-10)

☐ Second cycle secondary school (Grade 11-12)

☐ Higher education (Diploma, Degree, Masters, Doctorate)

☐ Uneducated

5. How do you perceive crossing the Ring Road in Addis Ababa without using a pedestrian overpass?

Very Dangerous ☐ Dangerous ☐ Safe ☐ Very Safe ☐

6. Which of the trips listed below are you making (your destination)?

Work ☐ Medical ☐ Return Home ☐ Business/ Shopping ☐ Transit ☐

School ☐ Social ☐ Recreation ☐ Religious Center ☐

7. How do you rate the location of the overpass for the purpose of your trip that you are currently making?

Excellent ☐ Good ☐ Satisfactory ☐ Poor ☐ Very poor ☐

8. Do you know that crossing the Ring Road by jumping over the barriers is illegal and punishable by traffic law of Ethiopia?

Yes ☐ No ☐

9. How do you rate the adequacy of the width of the overpass to cross the Ring Road?

Excellent ☐ Good ☐ Satisfactory ☐ Poor ☐ Very poor ☐

10. How do you rate the congestion you face on the overpass due to the existence of other pedestrians on it?

Extreme ☐ Good ☐ Satisfactory ☐ Poor ☐ Very poor ☐

11. How do you rate the negative effect of illegal vendors on the overpass and on you as a pedestrians?

No effect ☐ Slight effect ☐ High ☐ Very High ☐

12. If this Overpass was not here, would you walk to the next overpass or safe crossing rather than crossing over the barriers?

Yes ☐ No ☐

If your answer is NO, please write your reason____

13. How do you evaluate the spacing between pedestrian overpasses or other crossing treatments along the Ring Road?

Very large spacing ☐ Large spacing ☐ Acceptable spacing ☐ Close spacing ☐

Do you think that the spacing between the overpasses hinder pedestrian from using the facilities?

Yes ☐ No ☐

14. Do you think that providing additional pedestrian overpasses would prevent pedestrians from the act of illegal crossing activity?

Yes ☐ No ☐

15. Compared to crossing the Ring Road using the overpass, how do you rate the time you think will save by crossing at grade?

<0% ☐ 5% - 25% ☐ 25%-50% ☐ 50%-75% ☐ >75% ☐

16. Which thematic area do you think needs immediate attention to curb the problem that pedestrian face or create while crossing the Ring Road?

☐ Safety awareness programs
☐ Law enforcement
☐ Aesthetic factors
☐ Additional provision of overpass
☐ Increase the barrier height
☐ Maintenance of overpasses & barriers
☐ Accessibility consideration for disabled
☐ Spacing reduction
☐ Relocation of schools, markets
☐ Relocation of the overpass
☐ Remove illegal vendors & beggars on it
☐ All need immediate attention

Others (please write) ____

17. How do you rate the accessibility of the overpass (are popular destinations such as schools, markets, health and religious centers within easy walking distance)?

Excellent ☐ Good ☐ Satisfactory ☐ Poor ☐ Very Poor ☐ Inaccessible ☐

18. How do you rate the design of the overpass with respect to accessibility for disabled pedestrians such as wheelchair users?

Excellent ☐ Good ☐ Satisfactory ☐ Poor ☐ Very Poor ☐ Not usable ☐

19. With reference to pedestrian generating and attracting land uses such as school, health centers, market areas and religious centers along the Ring Road, how do you rate the appropriateness of the location of the overpass?

Excellent ☐ Good ☐ Satisfactory ☐
Poor ☐ Very poor ☐ Inappropriate location ☐

If your choice is 'totally inappropriate location', recommend preferable location option please______
____

20. What mostly influences your judgment/decision in using a pedestrian overpass when you cross the Ring Road?

Distance ☐ Time ☐ Safety ☐ Attractiveness ☐
Location ☐ Comfort ☐ Energy ☐ Traffic volume ☐

21. How do you rate the capacity of the overpass compared to the number of pedestrians in need of it to cross the Ring Road around this locality?

Excellent ☐ Good ☐ Satisfactory ☐ Poor ☐ Very poor ☐ Incapable ☐

22. How do you rate the additional provision of overpasses along the Ring Road solve the problem of illegal crossing or enhance the utilization of the overpasses?

Problem will be curbed fully ☐ Problem will be curbed partially ☐ No change at all ☐

23. While there is a pedestrian overpass nearby (within a distance of less than 100m), what do you think of the reason that made pedestrian not to use it?

☐ Absence of law enforcement (traffic police) nearby
☐ Because the overpass is not comfortable
☐ Congested by illegal vendors & beggars
☐ The overpass is aesthetically poor (un-attractive)
☐ It took long time to cross (save time)
☐ It is too far from origin/destination of pedestrians
☐ Congested by pedestrians
☐ Vibration of the overpass
☐ Small traffic that endanger safety
☐ Afraid of Height
☐ Not located on the proper area
☐ Lack of awareness

Other reasons (please write) ____

24. How do you rate the emphasis given to pedestrian access, safety and connectivity prior to providing the Ring Road and the crossing facilities?

Excellent ☐ Good ☐ Satisfactory ☐ Poor ☐ Very poor ☐ Not Considered ☐

-------------- Thank You for Sparing Your Precious Time ---------------