



**THE CHALLENGES FACING PEDESTRIAN PATHWAY: THE
CASE OF IMPERIAL HOTEL TO GERJI (ROBA BAKERY)**

**A MASTER'S THESIS
BY
BEREKET AKLILU SIME**

**DEPARTMENT OF BUSINESS MANAGEMENT
ADDIS ABABA SCIENCE AND TECHNOLOGY
UNIVERSITY**

AUGUST, 2021

ADDIS ABABA, ETHIOPIA



**THE CHALLENGES FACING PEDESTRIAN PATHWAY: THE CASE OF
IMPERIAL HOTEL TO GERJI (ROBA BAKERY)**

**By:
BEREKET AKLILU SIME**

A Thesis Submitted as a Partial Fulfillment for the Degree of Master of Business
Administration in Construction management

to

**DEPARTMENT OF BUSINESS MANAGEMENT
ADDIS ABABA SCIENCE AND TECHNOLOGY
UNIVERSITY**

AUGUST, 2021

ADDIS ABABA, ETHIOPIA

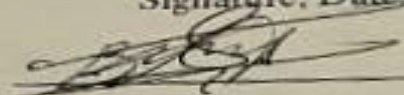
Declaration

I Bereket Aklilu, do hereby declare that this thesis "The Challenges Facing Pedestrian Pathway: The Case of Imperial Hotel to Gerji (Roba Bakery)", is my original work and that it has not been submitted partially, or in fully, by any other person for an award of a degree in any other university or institution that all sources of material used for the proposal have been acknowledged.

Author:

Bereket Aklilu

Signature, Date



Witnessed by:

Advisor:

Dugassa Mulugeta (PhD)

Signature, Date



Certificate

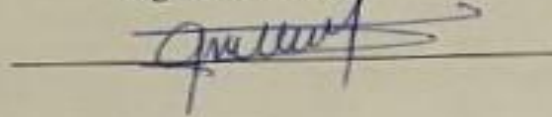
The undersigned certify that they have read and hereby recommend to the Addis Ababa Science & Technology University to accept the thesis submitted by Bereket Aklilu and entitled as "the challenges facing pedestrian pathway: a case of Imperial Hotel to Gerji (Roba Bakery)" in partial fulfillment for the Degree of Masters of Business Management in Construction Management with the regulation of the university and meets the accepted standard with respect to originality, content and quality.

Signed by Examining Board:

External Examiner:

Gidey G/Hiwot (PhD)


Signature, Date:



Internal Examiner:

Mengesha Yayu (PhD)

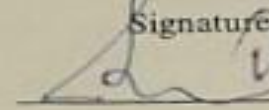
Signature, Date:

 23/08/2021

Chairperson:

Geremaw Tefay

Signature, Date:

 23/08/21

DGC Chairperson:
Dr. Essayas Taye Lemma
Department Head of Business
and Management

Signature, Date:

 23/08/21

College Dean/Associate Dean for GP:

Signature, Date:



Abstract

Walking is a basic human activity, and is usually the first and last mode used, providing an important link between land use and motorized travel. Pedestrian facilities are any pedestrian-related infrastructures, such as crosswalks, intersections, and sidewalks. They provide the only mode of transit available to all people, able and disabled. Pedestrian safety is a critical issue in Ethiopia. Reports show that 50 to 60% of traffic fatality victims in the country are pedestrians (WHO, 2013a; 2009). Despite this, the pedestrian pathway of Addis Ababa is by far one of the lowest by any international standards, the streetscapes is a serious problem in the city, street furniture's are not well designed, in some active area of the city side walk width is not enough for people to walk. Therefore, removing obstacles and making safety for pedestrians has become a very integral part of any transport planning. The aim of this study is to investigate the challenges that are facing pedestrian pathway and its impacts on people movement from Imperial hotel to Gerjii (Roba Bakery) and it covers 1.2mile or around 2km. The study also enquires the rate of utilization, location appropriateness, spacing, and level of service of pedestrian pathway. Three local reference points along the Imperial hotel to Gerjii (Roba Bakery) road were selected. Guideline from HCM2010 was used to determine the Pedestrian Level of Service based on three flow rate (VP), average pedestrian space/area (AP) and volume to capacity ratio (V/C). Primary data like pedestrian count every 15-minute; questionnaire survey, field observation and pedestrian level of service measurements are used. Hence, in this study 185,012 pedestrian were observed during pedestrian count. The observation was made 20 meter distance of visually cleared in both directions of three selected locations. A total of 385 questioners were distributed to pedestrian users out of which 376 responded fully and 9 failed to complete the questionnaire. The result also showed that most of Pedestrian facilities like pedestrian amenities, availability and visibility conditions of crossing areas, streetlight and walkway surface quality, and walkway management was very poor. There is were no designated places for street vendors and so they use spaces meant for pedestrian movement. The level of service of the facilities were computed by taking in to account of the volume of three more crowded pedestrians' location (P1, P2, and P3) at each location volume of pedestrian and the overall facilities can accommodate pedestrians with a level of pedestrian level of service measurement at C, D but some parts fall to E at both morning and afternoon pick hours of Gerji Roba and Taxi Tera , and at off-pick hours all are fall at a level of pedestrian level of service measurement at A, this imply that of the pedestrian pathway is moderate walking condition to serve all pedestrians. Based on result these recommendations have been forwarded in respect of Addis Ababa Planning commission and Addis Ababa City Administration needs to focus on improving its transportation facilities, adequate and widely provision of road safety education, disability infrastructures, raised zebra crossing and connect to walkway with ramp, marking zebra crossing, constructing, maintenance and management of walkway. Improvement needs that can be achieved based on pedestrian's awareness of the condition of the sidewalk found that the absence of disability infrastructures and using walkway to parking and washing, impact of road side vending, narrow, not comfortable and in accessibility of walkways are the most that need prioritization for improvements.

KEY WORDS: pedestrian, pedestrian pathway, level of service, Pedestrian Safety

Acknowledgement

This thesis is a result of the academic research thesis paper learning process in the construction management program it could never have been accomplished without God Almighty His blessing, mercy and power.

I deeply indebted to my lecturer, Dugassa M. PhD, for inspiring, guiding and accompanying my through thick and thin, and I thank God that he gave him as my advisor.

It has been a unique special session for interesting experience and unforgettable challenge throughout the whole learning process in the construction management program. I wish to express my love and gratitude to my beloved family, for their understanding and endless love throughout the duration of my learning process.

Before I finish, I express my gratefulness for all who directly or indirectly contributed to the initiation proposal and the successful completion of the write up.

Table of content

Content	Page
Declaration	Error! Bookmark not defined.
Certificate.....	Error! Bookmark not defined.
Abstract	III
Acknowledgement	IV
Table of content	V
Table of Table	VII
Table of Figure.....	VIII
Acronyms	X
1. Chapter One: Introduction	1
1.1 Background of the study	1
1.2 Problem Statement	3
1.3 Objectives of the study.....	4
1.3.1 General Objective.....	4
1.3.2 Specific Objectives	5
1.4 Research Questions	5
1.5 Significance of the Study	5
1.6 Scope and limitation of the Study	6
1.7 Organization of the Paper	6
2. Chapter Two: Literature Review	8
2.1 Introduction.....	8
2.2 General description	8
2.3 Concepts of pedestrian pathway	10
2.4 The importance of safe walking.....	11
2.5 Global perspective of road traffic accident.....	12
2.6 Local Perspective of road traffic accident	12
2.7 Pedestrian Characteristics	13
2.8 Pedestrian facility types	14
2.9 Factors influencing route choice	14
2.9.1 Interaction and obstacles	14
2.10 Problems that affect people due to the obstructions appearing on pedestrian pathway	15
2.11 Human behaviour factors	16

2.12 Pedestrian Level of Service Concepts.....	17
2.12.1 Procedures to Compute Pedestrian Level of Service (P-LOS).....	20
2.13 Methods to Improve Pedestrian Safety	23
2.13.1 Street Design Improvements	23
2.13.2 Street Connectivity Improvements	23
2.13.3 Site Design Improvements	24
2.13.4 Land Use Improvements	24
2.13.5 Access Management Improvements.....	25
2.14 Elements to be considered in pedestrian pathway	25
2.14.1 Sidewalks and No Sidewalks	25
2.14.2 Continuity and Connectivity of Pedestrian Network	25
2.14.3 Pedestrians and Land-Use	26
2.14.4 Neighborhood Character	26
2.15 Finding Gaps	27
2.16 Conceptual framework.....	28
3. Chapter Three: Research Methodology	29
3.1 Introduction.....	29
3.2 Study Area	29
3.3 Profile of the Addis	30
3.4 Research Approach	31
3.5 Research design	31
3.6 Sampling Technique	32
3.7 Data sources	32
3.8 Data Collection, Presentation, Analysis Methods and Collection Procedures	32
3.8.1 Pedestrian Counting.....	33
3.8.2 Questionnaire.....	33
3.9 Sampling Method	34
4 Chapter Four: Analysis and Results.....	35
4.1 Introduction.....	35
4.2 Demographic distributions of the respondents	35
4.3 Pedestrian Environment observation results	36
4.4 Pedestrians Questionnaire Survey Results.....	38
4.5 Pedestrian safety movement	39
4.5.1 Road Amenities	42

4.5.2 Disability Infrastructure	44
4.5.3 Road side Vendors stress.....	45
4.5.4 Pedestrian Pathway uses for Street parking and car wash.....	46
4.5.5 Drainage Problems	48
4.6 Results of factors affecting Pedestrian Safety	48
4.6.1 Obstructions.....	48
4.6.2 Pedestrian safety.....	49
4.6.3 Pedestrian Behavior.....	50
4.6.4 Motorist Behavior.....	50
4.7 Test of Normality.....	51
4.8 Measurement of correlation	53
4.9 Analysis of Performance of Pedestrian Level of Service	56
4.9.1 General PLOS determination	56
4.9.2 Factors affecting PLoS	57
4.9.3 Pedestrian Level of Service (PLOS)	58
4.9.3.1 PLOS Based on Flow Rate (VP).....	58
4.9.3.2 PLOS Based on Average Pedestrian Space (AP)	62
4.9.3.3 P-LOS Based on Volume to Capacity Ratio (V/C)	65
5 Chapter Five: Discussion and summary of Findings	68
5.1. Pedestrian environmental effect of analysis	68
5.2 Pedestrian safety and infrastructure effect analysis	68
5.3 Factor affecting pedestrian safety	69
5.4. Effect of performance of pedestrian level of service	69
6 Chapter Six: Conclusions and Recommendations	71
6.1. Conclusions.....	71
6.2. Recommendations.....	72
Reference	XI
Appendix A.....	XVI
Appendix B	XX
Appendix C	XXI

Table of Table

Table 2. 1 Factors influencing routes by category and interaction	15
Table 2.2. Pedestrian Level of Service Criteria for Walkways and Sidewalks	19

Table 3. 1. Pedestrian location	30
Table 3. 2. Road Hierarchy	Error! Bookmark not defined.
Table 3. 3 Pedestrian levels of service boundaries on sidewalk	Error! Bookmark not defined.
Table 4. 1. Pedestrian Environment observation results	36
Table 4. 2. Test of Normality	52
Table 4. 3 Test of Kolmogorov-Smirnov and Shapiro-Wilk	52
Table 4. 4 Correlation	54
Table 4. 5. Obstruction characteristics and elements of pedestrians	57
Table 4. 6 Pedestrian levels of service boundaries on sidewalk	58
Table 4. 7. Sidewalks width	59
Table 4. 8 Volume of Pedestrians during the Peak and Off-Peak Periods	60
Table 4. 9. Level of service of flow rate at pick and off-pick hour	61
Table 4. 10. Pedestrian speed value	63
Table 4. 11. Level of service of pedestrian space at pick and off-pick hour	64
Table 4. 12. Level of service of volume capacity ratio at pick and off-pick hour	66

Table of Figure

Figure 2.1 Recommended pedestrian body ellipse for standing areas	21
Figure 3. 1 Location Map of Area	29
Figure 4. 1. Address and age	35
Figure 4. 2. Educational status	36
Figure 4. 3. Walking on carriageway	40
Figure 4. 4. Rate of congestion	40
Figure 4. 5. Adequacy of width	41
Figure 4. 6. Observation and types of accident	41
Figure 4. 7. Current Inconvenient traffic movement	42
Figure 4. 8 Adequacy of road amenities and availability of pedestrian facility	43
Figure 4. 9. Barriers to peoples with disabilities	45

Figure 4. 10. Comfortable pathway for disabled person.....	45
Figure 4. 11 Road vendor stress on pedestrian	46
Figure 4. 12. Street parking and car wash Pedestrian Pathway	47
Figure 4. 13 Pedestrian Pathway used for another function	47
Figure 4. 14. Drainage condition	48
Figure 4. 15. Obstructions.....	49

Acronyms

AACRA	Addis Ababa City Road Authority
AARTB	Addis Ababa Road and Transport Bureau
AASHTO	American Association of State Highway and Transportation Officials
AAWSA	Addis Ababa Water and Sanitation Authority
ADA	Americans with Disabilities Act
CBD	Central Business District
EELPA	Ethiopian Electric and Light Power Authority
EU	European Union
ERA	Ethiopian Road Authority
FIIDCA	Federal Integration Infrastructure Development Corporation Agency
HCM	Highway Capacity Manual
LOS	Level of Service
NGO	Non-Governmental Organization
NMT	Non-Motorized Transport
ORAAMP	Office for Revision of Addis Ababa Master Plan
PAS	Primary Arterial Street
PIDA	Programmed for Infrastructure Development in Africa
PLOS	Pedestrian Level of Service
PWDs	People with Disabilities
RSDP	Road Sector Development Program
RTA	Road and Transport Authority
WHO	World Health Organization
UHI	Urban Heat Island

1. Chapter One: Introduction

1.1 Background of the study

Walking is a basic human activity, and is usually the first and last mode of travel used, providing an important link between land use and motorized travel. It is also healthy, inexpensive and very environmentally friendly.

Pedestrian facilities are any pedestrian-related infrastructure, such as crosswalks, intersections, and sidewalks. They provide the only mode of transit available to all people, able and disabled. Since pedestrian facilities are offered to everyone, they must be maintained so they can remain accessible for everyone. If properly maintained, these facilities will offer pedestrian mobility, which provides clear, safe, and effective travel from place to place (*R.Tolley, 2003*).

Pedestrian safety is among one of the largest worries in the transportation and traffic engineering profession, especially where the walking mode of transport takes the dominant share. Pedestrian paths are an important part of everyday life and a common means of transportation for many people, especially those located in urban areas. In urban areas where mobility is impaired, many people feel the need to travel using other forms of transportation, especially cars, rather than walking to their destination. (T. Haile, 2018).

Pedestrians are the catalysts which make the essential qualities of community meaningful. They create the place and time for casual encounters and the practical integration of diverse places and people. Without the pedestrian, a group's shared view-its parks, walkways, squares, and courts end up being pointless hindrances to the auto. Walkers are the last measure of a group; they set the scale for both the middle and edge of our neighborhoods (P. Calthorpe, 1993).

Each year, more than 270 000 pedestrians lose their lives on the world's roads. Many leave their homes as they would on any given day for school, work, places of worship, and the homes of friends, never to return. Globally, pedestrians constitute 22% of all road deaths, and in some countries, this proportion is as high as two thirds. Millions more

people are injured in traffic-related crashes while walking, some of whom become permanently disabled. These incidents cause suffering and grief as well as economic hardship for families and loved ones (*WHO, 2013*).

In African countries, pedestrians account for the largest share of road traffic injuries and deaths. They are the third leading cause of death and disability in sub-Saharan Africa. Although walking has health benefits, the highest road traffic death rates in Africa are among pedestrians at 3.4 per 100,000 inhabitants, after motorized four-wheeled vehicle occupants at 5.9 per 100,000 populations. According to the latest WHO estimates, pedestrians account for 40% of all deaths in road crashes in Africa, which are estimated at 26.6 per 100,000 inhabitants. In our settings of huge urbanization with no real policy for city building, among the vulnerable road users, pedestrians are particularly exposed because of the lack of pedestrian facilities. (*Glèlè-Ahanhanzo et al., 2021*)

Thus, the importance of the environment and infrastructure measures and the need to implement road infrastructure measures integrating the protection of vulnerable road users such as pedestrians have also been highlighted by many scholars. As such, the execution of road infrastructure measures has proven to be effective in reducing deaths among pedestrians.

Pedestrian safety is a critical issue in Ethiopia. Reports show that 50 to 60% of traffic fatality victims in the country are pedestrians (*WHO, 2013a; 2009*). The major characteristics of Ethiopian cities are a variety of land uses. Pedestrians and vehicles are the two main inhabitants of urban roads. Nowadays, there is a focus on the development of urban roads, focusing only on solving the issues faced by vehicular traffic and the obstacles that face people walking. The result of this is that vehicular traffic occupies a larger number of roads in cities, leading to a number of conflicts arising between pedestrians and other non-vehicular users. The most basic step towards creating a safer city is by providing proper amenities for pedestrians.

A management method for people on foot is the walkway. Therefore, removing obstacles and making safety for pedestrians has become a very integral part of any transport

planning. Many urban areas focus on development at a very small scale, which results in congestion and leads to pedestrian-vehicular conflicts, especially at signalized intersections. Two behavioral sides of pedestrians are of interest to planners, i.e. how pedestrians move relative to others, their choice of route, and their decision whether to cross the road or not, etc. and how pedestrians' travel without any obstacles and times are affected by signal control measures. (*Er.Sachin Dass, 2017*).

1.2 Problem Statement

In Ethiopia, the mobility of people and motorization has increased due to the economic advancement achieved in recent years. As (Ministry of Transport, 2020) indicated, Ethiopia is experiencing rapid economic and population growth. An inclusive transport system is essential for the country's development. Although a majority of Ethiopians walk and cycle, motorized transport is still favored over non-motorized transport, leading to increasing congestion, worsening air quality, and poor access to employment and educational opportunities.

Thus, the unpleasant consequences of pedestrian crashes have become a more noticeable problem. As a country, the problem of pedestrian crashes is severe. For instance, 1,296 pedestrians were killed and 3,003 pedestrians were injured during 2008/09 in Ethiopia (Federal Police Commission of Ethiopia, 2010). Moreover, fatal crashes involving pedestrians comprised 50% of the total fatal crashes in the country and 35% of the injuries. According to the WHO (2009), pedestrian fatal crashes accounted for 55% of all deaths that occurred in road users in 2007.

Addis Ababa, home to 17 percent of Ethiopia's urban population, is at a pivotal moment in its modern history (UN-Habitat, 2017). The city is undergoing a wave of rapid population and economic growth. The number of private vehicles in the city is rapidly increasing, contributing to worsening congestion, loss of the public realm, air pollution, and traffic fatalities. Most residents depend on walking and public transport, and there are relatively few personal motor vehicles in the city. Nevertheless, pedestrians face many challenges, including inadequately sized footpaths, dangerous crossings, inadequate illumination, and poorly maintained infrastructure. Going forward, the city seeks to

prioritize non-motorized transport (NMT), including walking, cycling, and other forms of non-motorized mobility. (AARTB, 2018).

Obstruction elements are deliberately or not deliberately raised on pedestrian pathways and cause delays or accidents for pedestrians. Streets are often overcrowded, footpaths are narrow and roads are difficult to cross. In many areas, there are not enough places to sit, inadequate protection from the weather and footpaths are so crowded that pedestrians are forced into the road.

Increased pedestrian activity in the city puts pressure on the street network and generates crowding, especially at stations at peak hours. All pedestrians face many challenges. Overcrowding along narrow footpaths and difficulties crossing the road at ground level are some of them. In view of the earlier, pedestrian movement in Addis Ababa is poor, so it requires a detailed study with practicable recommendations for implementation to improve the welfare of the pedestrians.

So, this research adopted a structured approach to the development of models or principles, which can be used to plan for a safer and more comfortable pedestrian pathway environment for pedestrians.

1.3 Objectives of the study

The objectives of this study consist of general and specific objectives. It emanated from current problems existing on the site.

1.3.1 General Objective

The general objective of the study is to assess the challenges that are facing pedestrian pathways and their impacts on people's movement from Imperial to Gerjii (Roba Bakery) and to give some possible recommendations.

1.3.2 Specific Objectives

1. To assess obstruction types and their characteristics.
2. To examine pedestrian behavior that influences pedestrian exposure that leads to crashes.
3. To measure the performance of the pedestrian facilities along the study area is sufficient to accommodate all pedestrians.

1.4 Research Questions

The research is intended to deliver answers to the following questions with regard to the challenges that are facing pedestrian pathways and have an impact on people's movement. Hence, the critical questions are:

1. What are the obstruction types and characteristics that influence pedestrian injury severity due to obstructions appearing on pedestrian pathways?
2. How does pedestrian behavior contribute to exposure?
3. Is the performance of the pedestrian facilities along the study area sufficient enough to accommodate all pedestrians and meet the diverse pedestrian requirements?

1.5 Significance of the Study

This study, generally, has the following major significance:

This research has an academic relevance for the research which will be carried out on the same topic. At the same time, the town municipality will use it as a reference while they are preparing their annual plans in relation to spatial and financial plans and to reduce pedestrian crashes on the pedestrian pathway infrastructure.

It will serve as a reference for maintaining the pedestrian pathway, so that it can be newly added or upgraded. It will be an alternative means of solution to ensure sustainable development in Addis Ababa by strengthening socioeconomic activities in regard to providing pedestrian pathway infrastructure. It will be of help to policy makers, academicians, and be used as a literature for other researchers who are interested in the same area of study.

1.6 Scope and limitation of the Study

The scope of this study provides the current pedestrian infrastructure and is limited to the Imperial Hotel to Gerji Roba in the Bole sub city. Furthermore, the study was on the challenges of facing pedestrian pathways rather than the whole sub city.

The scope of the study is used to know what the challenges affecting walkway infrastructure for pedestrian movement or pedestrian friendly are and to assess the obstructions, accidents, behavior of pedestrians and motorists, and measurement of pedestrian level of service. The limitations are, the current pedestrian infrastructure is limited from Imperial Hotel to Gerji Roba in Bole sub city, the difficulties of covering the study location, the study didn't include carriageway and excluded traffic office, AACRA, and other concerned bodies due to resource limitations.

1.7 Organization of the Paper

The preliminary pages of the paper consist of the title or cover page, deceleration, approval, acknowledgment, table of contents, list of tables and figures, list of annexes, list of acronyms, and abstract.

The body of this paper contains five chapters. Within each chapter there are different but interrelated sub topics. The first chapter contains the introduction part, which comprises the background, problem statement, research questions, objectives, significance, scope, description, and limitations of the study, operation definition of key terms, and organization of the paper.

The second chapter consists of the literature review part, which contains general, theoretical and empirical evidence on the challenges that face pedestrian pathways. The third chapter was the research materials and methods, which covers the research methodology, research design, research approach, research methods, sample design, data source, data type, and gathering tools, data analysis, and presentation of the research. Chapter four is data analysis and interpretation. And chapter five is the discussion part and the final chapter that provides the summary of findings, conclusions, and recommendations of the study.

2. Chapter Two: Literature Review

2.1 Introduction

The importance of walking in urban design and the problems of pedestrians in cities are established. There is a brief insight into some of human physiological and psychological factors that affect the planning and design of pedestrian spaces. The traffic and space characteristics of pedestrians are developed in sufficient detail for an understanding of pedestrian traffic relationships. Descriptions of pedestrian- traffic interactions at various human space occupancies provide a useful supplement for evaluating the environmental design quality of pedestrian building and street spaces. Standing on this fact, this sub-part of the research employed an attempt to explore and provide the basic concepts and understanding of pedestrian pathway, its implementation and management, theories and principles, factors for effective pedestrian pathway plan and design implementation and, legal framework and policy issues like standards for pedestrian. Finally, lessons that could be learn from such various experiences review from the view of effectiveness of pedestrian pathway (*JJ. FRUIN, 1971*).

2.2 General description

A pedestrian is any person who is travelling by walking for at least part of his or her journey. In addition to the ordinary form of walking, a pedestrian may be using various modifications and aids to walking such as wheelchairs, motorized scooters, walkers, canes, skateboards, and roller blades. The person may carry items of varying quantities, held in hands, strapped on the back, placed on the head, balanced on shoulders, or pushed/pulled along. A person is also considered a pedestrian when running, jogging, hiking, or when sitting or lying down in the roadway. (*WHO, 2013*)

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. (*T. Haile, 2018*)

Some pedestrian risks and challenges are not necessarily included in the definition of a road traffic collision and are therefore omitted from official road incident data, for example, obstructions on roads, falls, trips and slips, stumbling, animal bites and personal security. These hazards can lead to serious injury and even death (*WHO, 2013*).

Pedestrian facilities addressed in this toolbox section include those located within street rights-of-way that are primarily adjacent to or parallel with the roadway, such as sidewalks, walkways, and roadside spaces used for pedestrian travel (*Hawaii Revised Statutes 291C-1*)

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*). 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.

Pedestrian travel is a vital transportation mode. It is used at some point by nearly everyone and is a critical link to everyday life for many. Designers must be aware of the various physical needs and abilities of pedestrians in order to ensure facilities provide universal access.

A number of 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 pedestrian facilities included in a project are determined during the planning phase based on: access control of the highway; local transportation plans; comprehensive plans and other plans (such as Walk Route Plans developed by schools and school districts); the roadside environment; pedestrian volumes; user age group(s); and the continuity of local walkways along or across the roadway (*Americans with Disabilities Act of 1990*).

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.

2.3 Concepts of pedestrian pathway

Pedestrian pathway is an important part of the total movement system of human activity. It is an essential transportation planning function because each trip by vehicle transport or rapid transit begins or ends with pedestrian movement.

Pedestrian pathway planning follows the same general procedures used in comprehensive land use and transportation studies; steps include inventory and reconnaissance, analyses and projections, concept and alternative development, and plan formulation and

appraisal. There are, however, obvious differences in scale, role of concept and joint development, and extent of private group participation. A freeway plan, for example, is regional in scale, whereas a plan for pedestrians focuses on a small geographic area. (*L. Herbert, 1972*)

Pedestrian travel has characteristics not found in vehicular movement. Most pedestrian trips are short in length and are highly concentrated in core areas. According to pedestrian pathway there are two guiding principles. The first is the concept of ‘safe walking’. Walking is a basic and common mode of transport with benefits to health and the environment. Measures must be taken to improve the safety of walkers. The second guiding principle is the ‘Safe System’ approach, discussed here as a framework for understanding and addressing pedestrian safety (*WHO, 2013*).

2.4 The importance of safe walking

We are all pedestrians since walking is a basic and common mode of transport in all societies around the world. Virtually every trip begins and ends with walking. Walking comprises the sole means of travel on some journeys, whether a long trip or a short stroll to a shop. In other journeys, a person may walk for one or more portion of the trip, for example, walking to and from bus stops, with a bus trip in between. Walking has well established health and environmental benefits such as increasing physical activity that may lead to reduced cardiovascular and obesity-related diseases, and many countries have begun to implement policies to encourage walking as an important mode of transport. Unfortunately, in some situations increased walking can lead to increased risk of road traffic crashes and injury. Due to the dramatic growth in the number of motor vehicles and the frequency of their use around the world as well as the general neglect of pedestrian needs in roadway design and land-use planning pedestrians are increasingly susceptible to road traffic injury. Pedestrian vulnerability is further heightened in settings where traffic laws are inadequately enforced (*WHO, 2013*).

2.5 Global perspective of road traffic accident

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.

2.6 Local Perspective of road traffic accident

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 12 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*).

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.

2.7 Pedestrian Characteristics

Pedestrians are not, and should not, be treated as a homogenous group. The criteria used to categories different types of pedestrian are not always consistent between the studies. In most there is recognition that physical ability, social roles and economic constraints play a part in the experience of being a pedestrian.

Pedestrians with a physical impairment, such as walking, sight difficulties are often given as a group who has particular needs in the pedestrian and urban environment. Age is often used as other criteria. Both the elderly and the young are often mentioned as particular types of pedestrian with different needs and interests. Gender is another criterion for categorizing pedestrians. For example, claim that the empirical work they conducted with regard to crossing facilities shows that valuations of different crossing facilities vary by age and gender. There is also evidence that people from poor or excluded backgrounds are more likely to walk than those from wealthier backgrounds, particularly if the household does not have access to a car (*Sharples and Fletcher, 2000*).

2.8 Pedestrian facility types

Sidewalks, Walkways, and Pedestrian Zones are types of facilities addressed in the HCM. These three facility types are separated from motor vehicle traffic and typically are not designed for bicycles or other non pedestrian users, other than persons in wheelchairs. They accommodate the highest volumes of pedestrians and provide the best levels of service, because pedestrians do not share the facility with other modes traveling at higher speeds. (*HCM, 2010*)

Sidewalks are located parallel and in proximity to roadways. Pedestrian walkways are similar to sidewalks in construction and may be used to connect sidewalks, but they are located well away from the influence of automobile traffic. Pedestrian zones are streets that are dedicated to pedestrian use on a full or part-time basis.

Pedestrian walkways are also used to connect portions of transit stations and terminals. Pedestrian expectations about speed and density in a transit context are different from those in a sidewalk context.

2.9 Factors influencing route choice

There are a number of policy documents that explicitly identify factors that are believed to act as barriers and obstacles to walking.

2.9.1 Interaction and obstacles

The experience of walking means that the individual is in interaction with the environment and with other users. Obviously pedestrians have identified four sub-categories relating to the interaction with the environment: pedestrian network; pedestrian environment; infrastructure provision and its management; land use and urban form. There are two sub-categories of interaction with others and they are: interaction with other pedestrians (and particularly personal security) and interaction with traffic. (*Hodgson, M. Page, M.R. Tight, 2004*)

Table 2. 1 Factors influencing routes by category and interaction

Interaction	Factor detail	Factor category
Pedestrian Interaction with environment	Pedestrian environment	Surface evenness, Footpath width Gradient Ramps steps Street furniture Benches; Carriageway width and no of lanes Crossing placement Crossing distance removed from traffic Crossing types: At grade pedestrian: Zebra, Pelican, toucan, traffic signal with pedestrian phase, Crossing types: At grade traffic: Traffic signal without pedestrian phase, (cycle phase etc), Crossing types: At grade: un-signalized, Crossing types: different grade pedestrian subway, bridge Drainage/puddles, car splashing Cleanliness: Dog fouling, Graffiti
	Pedestrian network	Connectivity Desire lines
	Urban form	Building blanks and back walls, Functionality Legibility Sense of place Scale: human or otherwise Car dominance
	Land use	Location of services, Mazes and street layout and distances
Pedestrian interaction with other traffic system users	Traffic	Volume, speed, composition, headlights, Fear, anxiety, intimidation, danger Traffic accelerating to 'beat' lights
	Personal security	Other users Intimidating behaviour/drunks

Source: Factors influencing route choice (2004)

2.10 Problems that affect people due to the obstructions appearing on pedestrian pathway

Shortfalls in the physical environment are the most obvious deterrent to walking. Reasons often mentioned include: Poor-quality (cracked, uneven, lighting or slippery) walking surfaces, missing footpaths or sections of footpath, obstacles on the footpath, including poorly placed street furniture, lack of footpath maintenance, including litter, and

overhanging vegetation, lack of continuous signing to potential destinations and pedestrian routes, missing or unsuitable crossing treatments creating severance and lack of rest areas, seating and shade (shelter from inclement weather)

Social and perceptual deterrents are also important. Potential deterrents include:

- ✚ a perceived lack of time to make journeys
- ✚ other modes perceived as more convenient
- ✚ a lack of confidence in the walking infrastructure
- ✚ a perception that pedestrians generally have a high social status, especially in relation to car drivers
- ✚ A perception that motorists do not properly understand the rights of pedestrians.

Organizational and institutional issues have shaped the environment so that walking is more difficult. These have been compounded by a relative lack (until recently) of a collective voice for pedestrians. According to the issues of Leah Preiss, (2006), other modes of travel being given a higher priority than walking, resulting in pedestrians not being realistically accommodated within schemes designed for other travel modes, a lack of knowledge and expertise among infrastructure providers and relevant professions on ways to provide for walking, a lack of research into pedestrians and walking journeys and Insufficient resources allocated to walking schemes.

All of the above interact, but addressing individual issues in segregation is unlikely to address all. A holistic view is needed to ensure the maximum benefits. (*L. Preiss, 2006*).

2.11 Human behaviour factors

A pedestrian is considerably more exposed than is a motorist, in both good and bad ways. A pedestrian travels much more slowly than other modal users and can therefore pay more attention to his or her surroundings. The ability to take in one's surroundings and get exercise while doing so can be part of the enjoyment of the trip. At the same time, a pedestrian interacts closely with other modal users, including other pedestrians, with potential safety, comfort, travel hindrance, and other implications. In addition, a pedestrian is exposed to the elements. As a result, a number of environmental and

perceived safety factors significantly influence pedestrian quality of service. In locations with large numbers of pedestrians, pedestrian flow quality is also a consideration.

Some pedestrian flow measures are similar to those used for vehicular flow, such as the freedom to choose desired speeds and to bypass others. Others are related specifically to pedestrian flow, such as (a) the ability to cross a pedestrian traffic stream, to walk in the reverse direction of a major pedestrian flow, and to maneuver without conflicts or changes in walking speed and (b) the delay experienced by pedestrians at signalized and un-signalized intersections.

Environmental factors also contribute to the walking experience and, therefore, to the quality of service perceived by pedestrians. These factors include the comfort, convenience, safety, security, and economics of the walkway system. Comfort factors include weather protection; proximity, volume, and speed of motor vehicle traffic; pathway surface; and pedestrian amenities. Convenience factors include walking distances, intersection delays, pathway directness, grades, sidewalk ramps, and way finding signage and maps, and other features making pedestrian travel easy and uncomplicated.

Safety is provided by separating pedestrians from vehicular traffic both horizontally, by using pedestrian zones and other vehicle-free areas, and vertically, by using overpasses and underpasses. Traffic control devices such as pedestrian signals can provide time separation of pedestrian and vehicular traffic, which improves pedestrian safety. Security features include lighting, open lines of sight, and the degree and type of street activity.

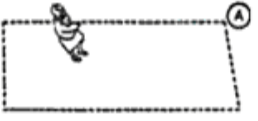
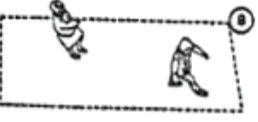
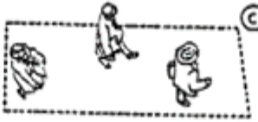



2.12 Pedestrian Level of Service Concepts

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. & Jain P., 2011). It is a measure used by traffic engineers to estimate effectiveness of the elements of transportation infrastructure.

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-8 of the HCM 2010 addresses the capacity and level of service analysis of pedestrian facilities.

The HCM defines LOS for most combinations of travel mode (i.e., automobile, pedestrian, bicycle, and transit) and roadway system element (e.g., freeway, urban street, intersection) addressed by HCM methodologies. Six levels are defined, ranging from A to F. LOS A represents the best operating conditions from the traveler's perspective and LOS F the worst. For cost, environmental impact, and other reasons, roadways and transit services are not typically designed to provide LOS A conditions during peak periods. Rather, a lower LOS that reflects a balance between individual travelers' desires and society's desires and financial resources is typically the goal. Nevertheless, during low-volume periods of the day, a system element may operate at LOS A. (*HCM, 2010*)

Table 2.2. Pedestrian Level of Service Criteria for Walkways and Sidewalks

L O S	Space (AP) (m ² /p)	Flow Rate (VP) (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.	

Source: HCM 2000

2.12.1 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 (2010) 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 (*Shahin, M. M., 2006*).

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:

$$W_E = W_T - W_O$$

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).

$$V_{15} = \frac{V_h}{15 \times W_E}$$

Where,

V_P = pedestrian flow per unit width (p/m/sec)

V_{15} = pedestrian flow rate during peak 15 min (p/h),

W_E = effective walkway width

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 as 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 0.75m² 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. (Rouphail et al., 1998)

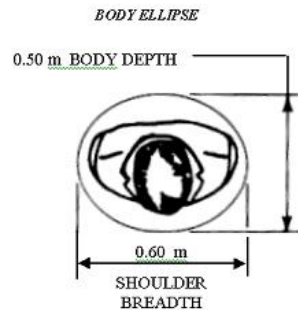


Figure 2.1. Recommended pedestrian body ellipse for standing areas

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 0.75m² 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.

$$A_P = \frac{S_P}{V_P}$$

Where,

A_P = pedestrian space (m²/p),

S_P = pedestrian speed (m/sec), and

V_P = pedestrian flow per unit width (p/m/sec).

Step 4: Calculation of Volume to Capacity Ratio (V/C): HCM 2010 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 labeled A to F on the basis of flow rate, average pedestrian space, average speed and volume to capacity ratio based on HCM 2010 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.

2.13 Methods to Improve Pedestrian Safety

In addition to improving the compliance of all roadway users with traffic controls and laws, there are several measures that can be taken to improve conditions for pedestrians within these transportation conventions previously discussed. Improved pedestrian safety can be achieved in a variety of ways, including. (*Charles V, Laura S, Margaret S, 2008*)

2.13.1 Street Design Improvements

To make streets safer for pedestrians, planners, designers, engineers, and officials need to focus on: Slowing vehicle speeds, Reducing street crossing distances for pedestrians, Improving the visibility of pedestrians and motorists, Increasing the level of caution taken by pedestrians and motorists, Providing pedestrian facilities (sidewalks, crossing islands, etc.) where the needs and potential crash reductions are the greatest by establishing a routine system to identify gaps in the network along streets and highways, particularly in urban and suburban areas.

Achieving one or more of these objectives not only reduces the risk of pedestrian crashes, but also usually improves safety for motor vehicle drivers and passengers. Sometimes a design issue may result in a complication or delay to other roadway users, and transportation officials will have to make a choice to balance the competing interests. Officials may perceive these choices to be unpopular or difficult to make, especially for those whose job has been to move motor vehicle traffic and who may not be aware of values held by the community. However, most often a community will be supportive of improved pedestrian safety; it is important to educate and inform people about how and why certain choices are made. (*Charles V, Laura S, Margaret S, 2008*)

2.13.2 Street Connectivity Improvements

Increasing street connectivity creates a safer, more pedestrian friendly street system by: Reducing walking distances, Offering more route choices along quiet local streets, Dispersing motor vehicle traffic with more two-lane, neighborhood commercial streets, which relieves motor vehicle traffic from arterials to makes streets safer for pedestrians to walk along, Reducing the need for wide, difficult to cross streets and intersections by

providing more connections. (*Charles V, Laura S, Margaret S, 2008*).

Street connections are vital to pedestrians, and there are many things that can be done to improve the connectivity of existing street networks and plan for the connectivity of future developments. Here are a few potential solutions: Improve existing local street connectivity and circulation by adding sidewalks, paths, stairs/ramps, gates, and etc. to link dead-end streets and cul-de-sacs to other, Maintain a pedestrian connection (e.g., provide a path in the right-of-way or sidewalk easement) when a street is being severed (it is more difficult to purchase an easement for a connection later), Increase the number of access points to and from neighborhoods and other destinations, so not all trips are funneled through one or two large intersections or access points. More neighborhood travel options means less motor vehicle traffic on any given street. (*Charles V, Laura S, Margaret S, 2008*).

2.13.3 Site Design Improvements

Both small-scale and large-scale developments should be directly accessible from the sidewalk through a safe and convenient sidewalk or pathway. Many communities are achieving better pedestrian safety records by requiring businesses and developments to locate close to the street (with parking provided in the back) in more pedestrian-oriented site developments that balance auto access with pedestrian needs and facilities. This does not mean that auto access is denied; it is just managed more appropriately.

These site design goals are achieved by enacting local zoning ordinances, which must be enforced. These principles contribute greatly to the safety, comfort, and aesthetics of the walking experience (*L. Preiss, 2006*)

2.13.4 Land Use Improvements

Land use planning has often been considered a discipline separate from transportation planning, street design, and traffic engineering, and insufficient emphasis has been placed on the coordination of the two planning processes. However, the relationship between land use and transportation is evident, and the responsibility to coordinate between the two is imperative. Some changes to land use patterns that may positively influence pedestrian safety (*L. Preiss, 2006*)

2.13.5 Access Management Improvements

One of the most important access management techniques includes reducing conflicts at driveways to improve the walking environment. Some driveways can be closed increasing the safety of both pedestrians and motorists without impeding access to local businesses. Access management tools should not be used to reduce public street connections, especially pedestrian connections to the transportation network. Other access management goals can work in favor of pedestrians within the context of other important planning and policy issues. (*L. Preiss, 2006*)

2.14 Elements to be considered in pedestrian pathway

Streetscape should be the best places for walking and it contains many design elements to create streets that feel right to people on foot. Street trees, separation from traffic, seating areas, pavement design, lighting, and many other factors should be considered in locations where pedestrian travel is accommodated and encouraged (*K. Bisrat A. and H. Yordanos, 2016*)

2.14.1 Sidewalks and No Sidewalks

Sidewalks offer many benefits to neighborhoods. They provide safe places for people to walk when they go to school, to the park, to a friend's house, to the bus stop, to shop, or to eat out. They also facilitate safe neighborhoods by encouraging self-surveillance as people commute, exercise, socialize and play. Sidewalks are to pedestrians as streets are for the cars. Where there are no sidewalks, pedestrians must either walk in the street or develop worn rut path adjacent to the street. Where there are parked cars or high volumes of high-speed traffic, walking in the roadway travel lanes is both uncomfortable and unsafe. Worn rut paths are inaccessible for pushing strollers and people using wheelchairs (*Journal, September 11, 1997*).

2.14.2 Continuity and Connectivity of Pedestrian Network

A continuous pedestrian network connects neighborhoods and makes it possible for pedestrians to get from where they are to where they want to go. Highways can be barriers to people on foot, but tunnel under Beltline makes it possible for them to cross

safely.



2.14.3 Pedestrians and Land-Use

Malls that extend to the sidewalk and have parking adjacent to the building, like the new Third Lake Market shown here are convenient for pedestrians, bicyclists and motorists alike. Street trees, landscaping, and the detailed architectural style create an inviting pedestrian setting. When stores are not directly connected to the pedestrian network, pedestrians must navigate large parking lots when they wish to shop. This can be dangerous when pedestrians are slow moving or are not tall enough to see or be visible to others in the midst of the parked cars. Before Westgate's recent refurbishing, its parking lot proved user-unfriendly for pedestrians, bicyclists and motorists alike. Things can change for the better: pedestrians now have a direct sidewalk connection to them all's main entrance from Whitney Way and the striped pavement markings alert motorists to watch out for pedestrians.

2.14.4 Neighborhood Character

The Jenifer Street Bridge is a defining neighborhood feature that provides a scenic, pleasurable pathway to the nearby school and their popular destinations throughout the neighborhood.

The above walking tour has provided a snapshot of a few situations pedestrians may encounter as they travel around Madison. Some of the situations explored promote accessible, convenient, safe and enjoyable pedestrian travel; others do not. Observing situations that pedestrian's encounter suggests criteria that can be used to evaluate the pedestrian-friendliness of an area and standards that should be strived for in making Madison a better place to walk. After two public workshops designed to solicit input concerning what people feel are the essential criteria of a walk able neighborhood, participant comments could be consolidated into three categories:

-  Plan, construct and maintain a continuous network of pedestrian walkways;
-  Ensure that pedestrians can safely and easily cross streets at intersections and other appropriate locations; and

- ✚ Support and encourage compact, mixed land use patterns, traffic calming measures and neighborhood traffic management plans.

Participant evaluation of each criterion focused on comments related to particular pedestrian facilities. Therefore, understanding arguments for providing each facility and issues to consider when making the decision about whether or not to provide a particular facility is an important step in developing goals and objectives defining the ideal pedestrian environment that Madison would like to achieve (*M. Rosen, 1997*)

2.15 Finding Gaps

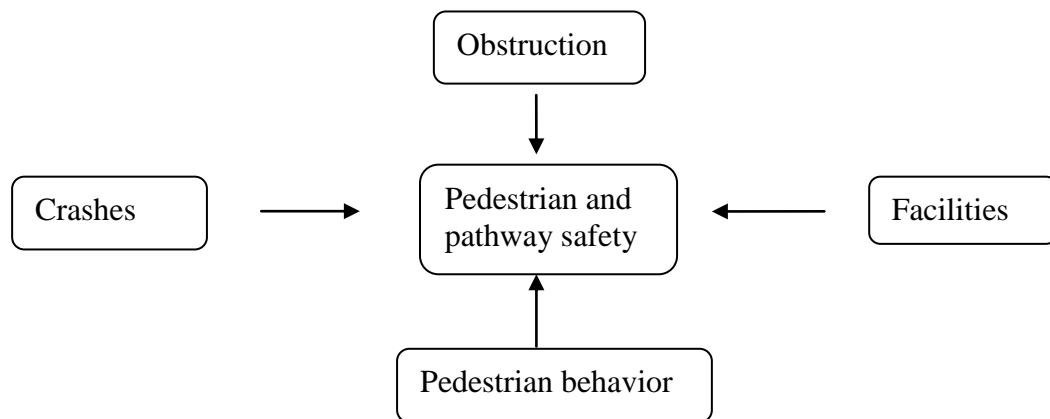
The pedestrian pathway has great importance for passengers, growth and development in economic, social and political aspects. Many authors wrote about pedestrian pathways in different parts of the world. The studies about the challenges of pedestrian pathways took place in the street. Moreover, no researcher did any comprehensive research on the challenges of the pedestrian pathway from the Imperial Hotel to the Gerji Site. The researcher was observing the challenges of a pedestrian pathway in the city. Therefore, it is intended to study the challenges of pedestrian pathways.

The researchers' motive was to do a study on a selected street. The pedestrian pathway consists of a large number of elements and this research focused on obstruction type and its characteristics, pedestrian behavior, the performance of the pedestrian facilities and the possible remedial measures to ensure a safe and comfortable pedestrian pathway. They are interrelated and interconnected to one another. The research is about analyzing the challenges of pedestrian pathways in urban areas. The researcher understands the real availability of elements for pedestrians and attempts to find a safe, comfortable, and attractive pedestrian pathway.

The pedestrian pathway is analyzed in the form of the number of pedestrians and vehicles, distance walked, and time taken to reach the station from their house. In addition, assess the availability of pedestrian elements of infrastructure. In addition, figure out the challenge of pedestrian pathways in street areas. Identify which pedestrian elements are missed, obstructions and causing accidents and which are well done for accessibility; understand the physical infrastructure of each pedestrian element.

Eventually, it will bring an advanced solution to the problem of pedestrians on the selected site. After clearly interpreting the gap, the possible solution is forwarded to the concerned body. The possible solution is not only recommended to government sector road authorities, but also forwarded to dwellers and NGOs which show how to solve the inefficient pedestrian pathway. In the end, the study will narrow the gap between challenges and provide a safe pedestrian pathway. In general, this study recommends a solution forward to dwellers' government and dwellers in order to take every concerned body their responsibility.

2.16 Conceptual framework



Source: Own source

3. Chapter Three: Research Methodology

3.1 Introduction

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

3.2 Study Area

The pedestrian pathways assessed were provided along the Imperial Hotel (Wuha Limat) – Gerji Taxi Tera – Roba Bakery road, which is one of the Bole sub-cities that have a dense population movement on crowded roads. The studies were conducted at three main stations which have more pedestrian movement.

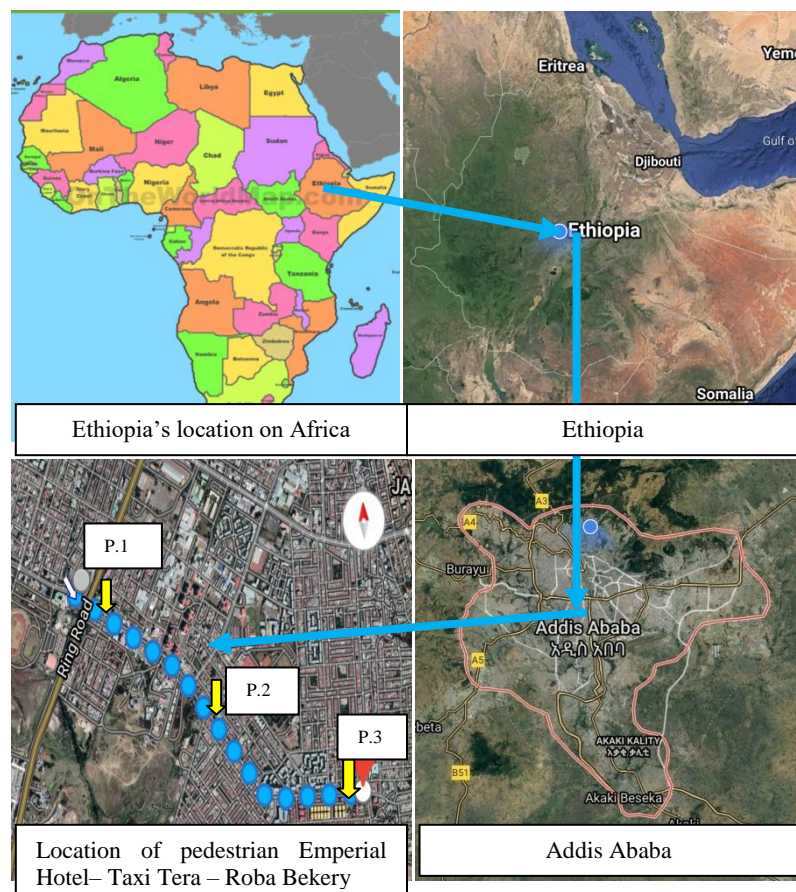


Figure 3. 1 Location Map of Area

Source: Own source

Labels and Locations of more pedestrian movement With Reference to Local Names

Table 3. 1. Pedestrian location

labels	Pedestrian Location (Local Reference landmark)
P.1	Imperial Hotel (Wuha Limat)
P.2	Gerji Taxi Tera
P.3	Roba Bakery

Source: Own source

NB: “P” is short label for pedestrian

3.3 Profile of the Addis

Addis Ababa, the political capital and the most important commercial and cultural centre of Ethiopia, is geographically located at the heart of the nation at 9°2’N latitude and 38°45’E longitude. Its average altitude is 2,400 meters above sea level, with the highest elevation at Entoto Hill to the north reaching 3,200 meters. This makes Addis Ababa one of the high-altitude capital cities in the world.

Addis Ababa occupies a total of 540 sq. km of land area surrounded by a mountainous landscape. At present, Addis Ababa's road network extends for a total of 5,915km, compared with 5,365km in 2014. Meanwhile, 2,616km of the city's roads are surfaced with asphalt, around 44% of the total network. (*World highway, 1018*)

Table 3. 2. Road Hierarchy

Road Hierarchy	Length of Varying width (Km)	Length of 7meter width (Km)	Road condition	Pedestrian Walkway		
A) Asphalt Roads				Left Side (Km)	Right Side (Km)	Total (Km)
Arterial	334	552	Very good	73	58	131
Sub Arterial	116	167	Very good	63	57	120
Collector	174	209	Good	55	55	110
Local	208	208	Fair	13	13	26
Total		1136		204	183	387
B) Gravel Roads		1521				
Total Network		2657				

Source: Addis Ababa road network and pedestrian walkway coverage as of 2010

The Addis Ababa road network does not have good interconnectivity and extent of coverage. The Office for Revision of Addis Ababa Master Plan (ORAAMP) described the road network as having poor quality of design standards, a shortage of pedestrian walkways, and being badly constrained by misuse and encroachment of road space (Abreha, 2007). Despite the high volume of pedestrians in the city, there are no footpaths over a greater proportion of the road network (*Meron, 2007; Abreha, 2007*).

As shown in the above *table*, as of 2010, over 66% of the road network is not pedestrianized. This is a major drawback of the existing road network and the newly planned ones. The absence of wide walkways over a greater portion of the road network results in a spillover of pedestrians onto the road. Though walking accounts for a greater proportion of urban trips, pedestrians are not the center of attention in the process of road design. On-street parking is also prevalent, and this creates congestion and inefficient utilization of road space. This shows, apart from the inadequacies of the road.

3.4 Research Approach

There were different approaches to conducting research depending on the nature of the study. In this study, the challenges that face pedestrian pathways and pedestrians in this study were defined in the study as all human beings using the pedestrian pathway in Addis Ababa Bole Sub-city from the Imperial hotel to Gerji (Roba bakery). Challenges were measured on an ordinal scale in terms of highest degree to lowest degree. This helps to know the severity of challenges and leads the researcher to use both qualitative and quantitative approaches.

3.5 Research design

A research design is a systematic plan to study a scientific problem, and one of the research problems were identified and defined after the steps follow to come across the objectives of the study from field observation, review of relevant literature, and formulation of appropriate methodology for data collection and analysis stages. Relevant information and key concepts are gathered from literature which is used to set different criteria to evaluate the performance and effectiveness of pedestrian pathways. Next, it developed a research question and established an objective, followed by developing an

applicable method to provide answers to the research questions. Statistical sampling techniques were used to gather the necessary data. The studies were descriptive and explanatory in order to achieve their purpose and objectives. They are suitable for the analysis plan at different levels. From the results found in the analysis stage, conclusions and recommendations were drawn.

3.6 Sampling Technique

This study was conducted by primary data collection in the field by using non-probability sampling type and convenience sampling techniques. Under the non-probability sampling method, the numbers of sample units were selected deliberately or purposely depending on the object of the inquiry so that only the important items representing the true characteristics of the population are included in the sample.

3.7 Data sources

To achieve the objectives of the study, both primary and secondary data were collected from the study area. The primary data was collected through a questionnaire and by inspecting the conditions faced by pedestrians while walking. Whereas, the secondary data was collected from AACRA, the traffic office, Ethiopian Roads Authority (ERA), and from the city government of Addis Ababa Road and Transport Bureau (AACRTB) and from other related government organizations.

3.8 Data Collection, Presentation, Analysis Methods and Collection

Procedures

The data types used in this study are primary data, which includes pedestrian count and the pedestrian unit flow rate (ped/min/ft). This data is obtained by taking the pedestrian 15-minute flow rate (ped/15-min) every 15-minutes for three weekdays at each site for 8 hours, field observation and measurements (dimensions like width and length of the walkway, spacing of pedestrian treatments along the road) and responses from pedestrians gathered through a questionnaire. The HCM, 2010 suggests collecting pedestrian opposing flow volumes at 15-minute intervals. The sum of the two directional flows is used as the 15-minute flow rate. The effective width of the sidewalk was calculated by taking the total width of the sidewalk and subtracting obstacle widths. Most

of the walkway environment from the Imperial hotel to Gerji Roba often presents obstacles to the movement of pedestrians. The absence of sidewalks that are properly paved and maintained restricts the mobility of people with the most varied sorts of limitations. Obstacle widths can be measured from the field. A questionnaire was distributed to users of pedestrian pathways on the road. To measure the convenience of the pedestrian furniture facilities, observation data was taken and recorded in the field. For the purpose of data presentation and analysis, a personal computer, the Statistical Package for the Social Sciences (SPSS), and a Microsoft Office tool (Microsoft Excel) will be used. The data types and collection procedures used in this study are briefed below.

3.8.1 Pedestrian Counting

Counting the number of pedestrians using both sides of the walkway was one of the tasks during the data collection process. Manual counting was implemented within the selected centers. The counting was held for 8-hours on three 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 count was also conducted at three locations where there was more pedestrian movement. Precaution was taken to select the counting days not to coincide with religious/public holidays, street demonstrations, as well as sports festival days which might distort the results.

3.8.2 Questionnaire

The Questionnaire is the simplest and time-saving method for collecting data effectively from a huge number of respondents. It is used to assess obstruction types and their characteristics, to identify and examine pedestrian injury severity due to obstructions appearing on pedestrians, and to observe the facilities' spacing, design, capacity, and accessibility as well as preferred remedial measures to maximize utilization rate with acceptable LOS and performance. A Questionnaire paper was distributed to pedestrians using the walkway and collected on the same day. It is distributed to a randomly selected pedestrian of a different age, gender, educational background, etc. A combination of closed-ended and open questionnaire types were used in which respondents could simply

select from closed questions and give opinions on some of the open-ended questions. The respondents were asked to rate the parameters to be assessed on a different scale of measures.

3.9 Sampling Method

In order to determine the sample size for the questionnaire survey respondents, the population is very large or unknown. Hence, for a population that is too large or not known precisely, the sample size (n) is determined using the equation below.

$$n = z^2 / e^2 \times p \times (1 - p)$$

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.

$$n = z^2 / e^2 \times p \times (1 - p)$$

$$n = 1.96^2 / 0.025^2 \times 0.5 \times (1 - 0.5)$$

$$n = 385$$

4 Chapter Four: Analysis and Results

4.1 Introduction

The central theme of this study is an assessment of the challenges facing the pedestrian pathway from the Imperial Hotel to Gerji Roba. It comprises all inclusive obstruction types and their characteristics, the behavior of pedestrians and motorists, the performance of pedestrian level of service and suggested remedial measures to improve the hindering factors related to the traffic movement system. An attempt is made to provide a safe and comfortable pedestrian pathway and explore the existing reality on the ground, mainly through assessment of produced documents during the preparation period, direct and on-spot observation of identified issues and questionnaires.

4.2 Demographic distributions of the respondents

The figure below shows where the pedestrians came from and used the pathway and illustrates that 81.4% of the respondents lived around the site and 18.6% came from other places. Age categories of the respondents and illustrates that 32.4% and 30.6% of the respondents are 15-30 and 31-45 years old respectively..

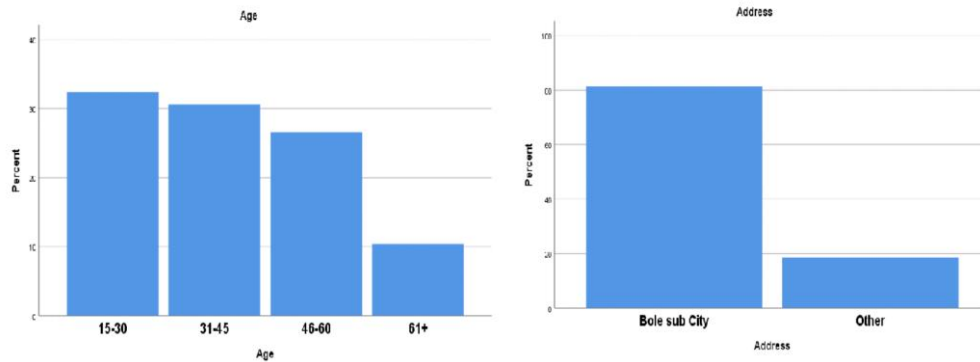


Figure 4. 1. Address and age

The figure below shows the number of respondents by their educational levels. Accordingly, respondents who were able to read and write, high school, certificates and diplomas, and degrees and above, and others were 18.6%, 14.6%, 18.1%, and 48.7% respectively.

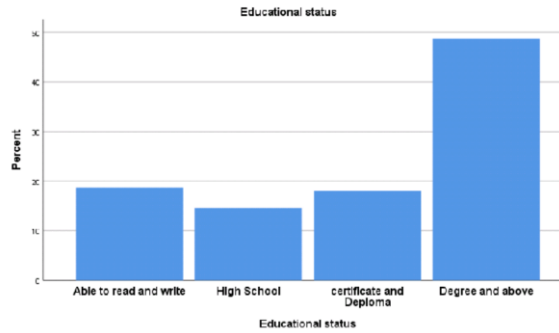








Figure 4. 2. Educational status

4.3 Pedestrian Environment observation results

Table 4. 1. Pedestrian Environment observation results

Guide	Description	Photo	Suggestion
Barriers on walkway	On the pedestrian pathways, there is an impediment in the form of ruined materials. Individuals discarded such waste materials on the pedestrian walkway and the government store for a length of time after leaving their residences		Reduces pedestrian safety and pollutes the environment substantially.
Walkway width	The site was also filled by street vendors, despite the narrow width and total lack of pedestrian pathways.		Cause walkway modal conflict and significantly reduce the PLoS, peoples with disability affected more.

Pedestrian walkway Plantations	Plantation was unsuitable, with severe obstacles for those with disabilities, making wheelchair movement impossible.		Make people move in a zigzag pattern to limit maneuverability.
Surface conditions	Surface condition of pedestrian walkways. There were issues, such as loose stones, which made it impractical to use.		Pedestrians' willingness to stroll is much diminished, and they attempt to intrude on main carriageways.
Drainage problems	There is open drainage and inadequate drainage upkeep. The ecology beside the roadside has deteriorated as well.		Drainage was found to be open and in need of maintenance. The environment along the highway has deteriorated as well
On street parking	Perpendicular parking takes up a substantial amount of the pedestrian path, and exiting the parking space might be hazardous due to vehicle visibility.		Sidewalk is completely blocked, making wheelchair mobility difficult. Reduces pedestrian comfort and encourages pedestrians to enter major carriageways.

Improperly located pedestrian facilities	Infrastructures for people with disabilities that aren't at the right place The presence of facilities was noticed..		Despite the fact that a ban is a good start, improperly positioned accessibility infrastructure causes blind people to clash with fixed items.
Pedestrian Crossing facilities	There are no guardrails guiding pedestrians to safe crossing locations, and the crossing is not marked for all vehicle users.		Pedestrians believe it is safe to cross, but the driver cannot see the marking because it is not visible, and there is no ramp.

Source: Owen source

The pedestrian pathway free from any obstruction is a very important for all; especially for children, elders and disables people. The cause of increase obstructions on pathway makes trouble movement.

4.4 Pedestrians Questionnaire Survey Results

A structured questioner was prepared in order to gather information for the challenges of pedestrian pathway analysis. As the pedestrian pathway is a function of people's perception of their safety and trip purpose, it was necessary to gather information and data on how the road users in my project or research corridor perceive the current situation.

The questionnaires were distributed to pedestrians at the case study, and the respondents filled them in. Accordingly, about 385 questionnaires were distributed and 376 were returned and analyzed. The researcher believes that statistically significant samples should be considered to draw conclusions out of analysis made on such questionnaire data. However, due to the fact that most of the basic analyses in this research are based on the quantitative data described before and the data on the questionnaire is a

supplement to the result, the respondent size would be sufficient for the purpose of this study.

4.5 Pedestrian safety movement

The field surveys were conducted in Bole Sub-City from the Imperial Hotel to Gerji Roba. The pedestrians walking in both directions were surveyed. Respondents mentioned several sidewalk characteristics that may facilitate/hinder improving safety, such as: sidewalk presence and continuity, sidewalk quality and maintenance, slopes and curbs, and temporary obstacles on sidewalks. Concerning sidewalk presence and continuity, participants preferred streets with sidewalks over streets that lacked sidewalks. Furthermore, they disliked abrupt endings to sidewalks, which forced them to walk on the street.

From respondents, 60.6% mentioned that walking without using a pedestrian pathway is very dangerous and 22.3% said dangerous. The others said safe and very safe, respectively, 12.8% and 4.3%. And their purposes of movement are dominantly for business or work at 59.3%, usually walking transportation mode users at 55.9% and other mode users at 44.1%.

In Addis, most of the time, pedestrians don't walk on sidewalks, even if sidewalks are available. For some reason, pedestrians like to share the road with cars. But, legally in Ethiopia, the traffic law of Road Transport Traffic Control Council of Ministers (Amendment) Regulation No. 395/2017 23rd year No.8 Addis Ababa 3rd January 2017 mentioned that "Pedestrians can't walk on the road when there is a sidewalk available".

And pedestrian knowledge of these rules is based on a questionnaire. 41.8% didn't know the rules and 58.2% had knowledge. Thus, pedestrians need awareness for their safety.



Figure 4. 3. Walking on carriageway

Source: Field survey

The pedestrian walking environment in any urban road segments like the footpath and different pedestrian facilities may tend to be affected due to various obstacles that decrease pedestrian safety. Pedestrian spaces should be designed in consideration of human convenience and have to be qualitatively suitable for the needs of human beings. The figure shows that due to the existence of obstacles, the congestion rate is very high at 32.4%, high at 39.9%, medium at 19.1%, few at 7.4% and very few at 1.1%.

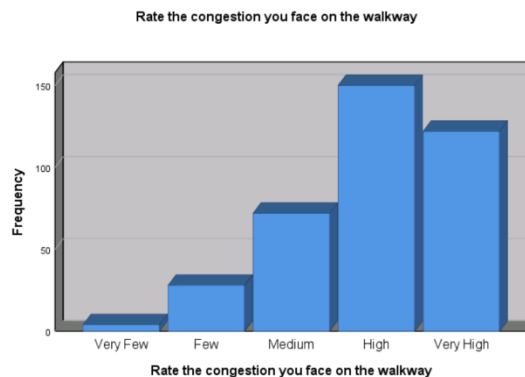


Figure 4. 4. Rate of congestion

The sidewalk width in different areas of urban areas in developed and developing countries is different based on the side features they use to enhance roadside safety. Wherever, roadside and land development conditions affect regular pedestrian movement along a sidewalk or path area. The figure below shows the number of respondents that rated the pedestrian pathway from Imperial Hotel to Gerji (Roba Bakery) as adequate.

Hence, the responses very poor, poor, satisfactory, good and excellent are 34.8 %, 50.5%, 9.3%, 4.5% and 0.8% respectively.



Figure 4. 5. Adequacy of width

Source: Field survey

Traffic accidents are known to be one of the major transportation problems in Addis Ababa, and the subsequent loss of life, injury and property damage are significantly high. The figures below illustrate any traffic accident occurrences seen while using a pedestrian pathway and the type of traffic accident events the respondent observed. Accordingly, 54% and 46% of respondents did not observe and observe accidents respectively, and the accidents fatalities, property damage, and property damage injuries were observed at 5.3%, 22.3%, 11.7%, and 6.9%, and not observed at 53.7%.

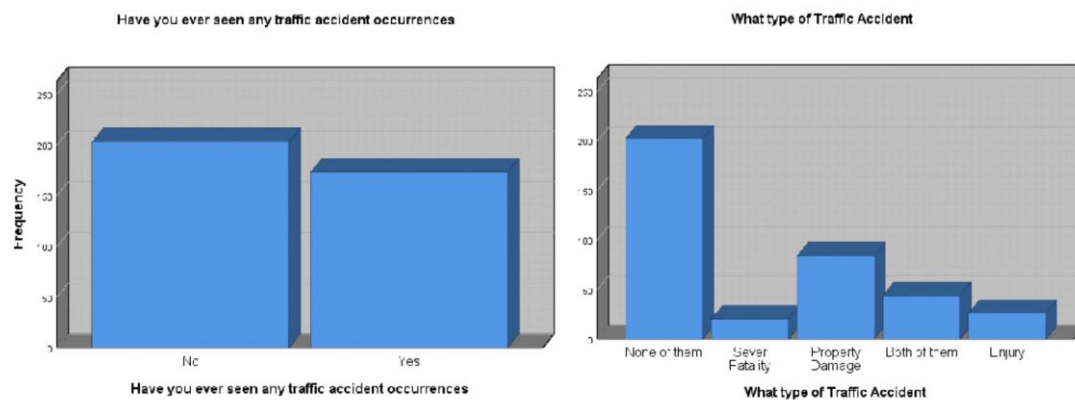


Figure 4. 6. Observation and types of accident

The road traffic movement system is highly affecting the population of developing countries, in which pedestrians are the most victimized due to lack of appropriate road traffic knowledge, inadequate pedestrian walkway infrastructure, encroaching of vendors on pedestrian walkways, etc. The problem seriously affected subject families and the communities at large. Similarly, the road traffic movement system affects pedestrians in Addis Ababa City at large, where road traffic infrastructure and efficient roads are inadequately available, notably mentioned as among the worst social problems. Accordingly, the current study showed that those responsible for the current inconvenient traffic movement system in the pedestrian pathway are pedestrians, traffic offices, and road authorities, and all are responsible for 5.9%, 5.1%, 25.5%, and 63.6 % respectively.

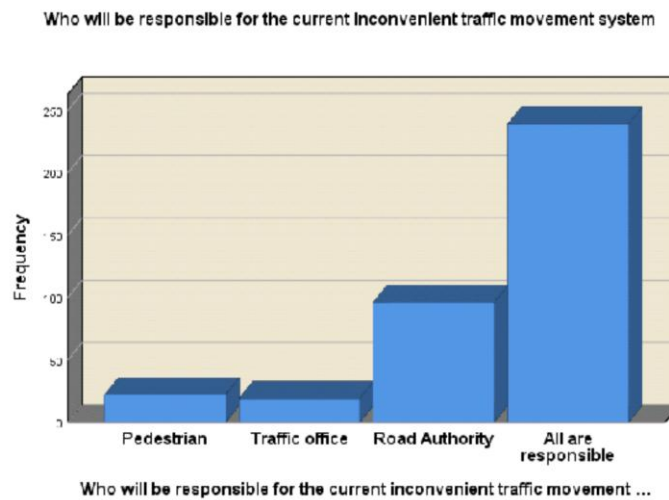


Figure 4. 7. Current Inconvenient traffic movement

4.5.1 Road Amenities

Pedestrian amenities are a useful or desirable feature of a place, the pleasantness or attractiveness of a place that increases the interest in walking for pedestrians. The pedestrian amenities for walking are affected by different factors. These amenities greatly enhance the attractiveness and convenience of the pedestrian environment, and, in turn, the city itself. These factors vary from place to place depending on the improvements made by governments, private organizations, and individuals. The unavailability of public services like chairs/benches, rain/sun shelters, public toilets, and the poor quality of sidewalk surface conditions negatively impact the interest of pedestrians in walking.

The field observation and pedestrian questionnaire results done in Bole Sub-City from the Imperial Hotel to the Gerji Roba area show that the availability of pedestrian walking paths were in very bad conditions. In this study, to investigate the availability of pedestrian facilities, the adequacies of road amenities were used as criteria. Accordingly, the survey results shown in the figure below illustrate that about 37.0% of available pedestrian facilities are very poor, 39.1% poor, 16.2% satisfactory and the other 3.5% and 4.3% are good and excellent respectively. The field observation also shows that the conditions of available walking paths were poor. There were severe walkways damaged by digging, washing a car and closed by obstructions. Figure below shows the details of the impact of the unavailability of pedestrian amenities.

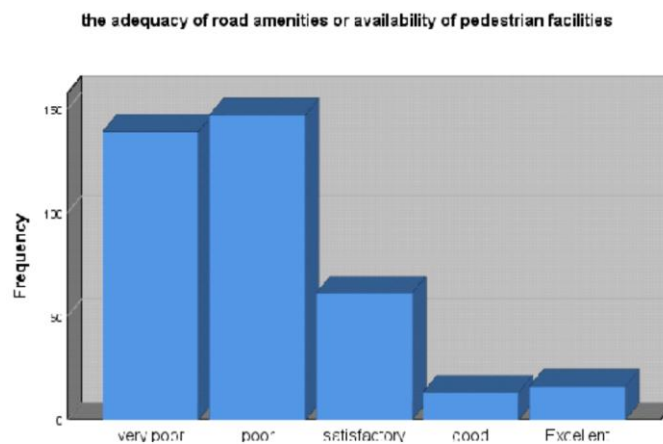


Figure 4. 8 Adequacy of road amenities and availability of pedestrian facility

Sidewalks play an essential role in transportation, as they provide a safe path for people to walk along that is separated from motorized traffic. It is a description of the quality of the path's surface. The continuity of the pedestrian facility is important for pedestrians with disability and of old age. Since the walkways from the Imperial hotel to Gerji Roba, in general, have the problem of sidewalk presence and continuity, sidewalk quality and maintenance, slopes and curbs, and temporary obstacles on the sidewalk, they create more conflict points between vehicles and pedestrians, thus reducing the effectiveness of footpaths.

4.5.2 Disability Infrastructure

Infrastructure for pedestrians needs to provide routes that are direct, continuous, safe, convenient, and attractive. Paths and sidewalks should be comprehensive, and provide for the journeys that people want to make, including routes through residential areas. They should be sufficiently wide (1.8m is a minimum, with at least 1.0m at pinch points), well surfaced and drained, lit at night and overlooked for personal security. Pedestrian routes should include frequent seats or resting places, because about 10% of adults cannot walk more than 400m without resting or experiencing pain, and 5% of adults cannot walk 50m. At least in town centers, pedestrian routes to major destinations should be signed. Ramped curbs should be provided wherever people may need to move from the sidewalk to the surface of the road.

Accessible infrastructure creates an inclusive environment for people with disabilities, allowing them to enjoy their civil, cultural, political, social, and economic rights and entitlements. It is also a precondition for independent living and full and equal participation in society by children and adults with disabilities.

The field survey observation showed that there were sidewalk segments that were not accessible to the concerned participants. One of the reasons was that design policy was not oriented towards the development of an inclusive city based on the universal design approach. Locating electric poles in the middle of sidewalks was one significant barrier that was identified in the study area. Other reasons for inaccessible segments were the existence of steep curbs, construction encroachment, illegal parking, street vendors, and improperly placed dust bins. Photos also show some sample barriers for people with disabilities. And the health conditions of pedestrians are categorized as: a small child, an elderly or infirm person, a pregnant lady, the temporarily disabled, wheelchair users, people with limited walking/movement abilities, people with visual impairment or low vision, people with hearing impairment, all are vulnerable to barriers.



Figure 4. 9. Barriers to peoples with disabilities

Accordingly, the survey results are presented. The figure below illustrates the pedestrian pathway has enough infrastructure for pedestrians. 48.1% and 51.9% of respondents said they have enough infrastructures. Therefore, improvement of walking ability infrastructure for people with disability needs priority.

the pedestrian pathway is comfortable or have enough infrastructures for disability persons

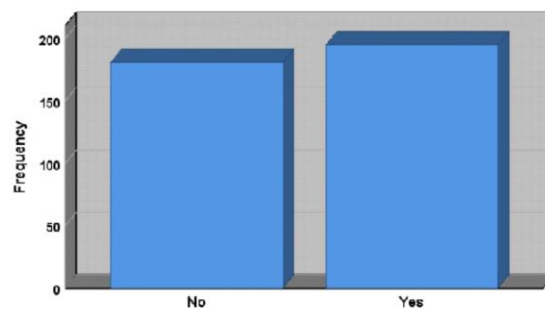


Figure 4. 10. Comfortable pathway for disabled person

4.5.3 Road side Vendors stress

Urban public space is the physical space and social relations that determine the use of space within the non-private realms of cities. It is the fundamental area for human activities and a determinant of the character of towns (Kimathi, 2004).

Urban public space is the physical space and social relations that determine the use of space within the non-private realms of cities. It is the fundamental area for human activities and a determinant of the character of towns (Kimathi, 2004).

According to Setsabi (2006), strategy often carries considerable risk that includes physical and psychological harm by authorities as well as the loss of wares and property. It is, nonetheless, a risk that the street vendors seem to weigh against the prospect of destitution, if they leave their current trading spaces. Again, street vendors, who are willing to risk re-occupying the streets, increase their mobility by picking a few items in their hands and selling to customers so that when the city guards appear, they can get away quickly, and highly disturbs the pedestrian movement. From the field observations, the major problems associated with pedestrians were the ever-increasing number of street vendors operating on sidewalks and on the streets. Consequently, there is intense struggle for space between the traders and the pedestrians are therefore, forced to walk on the streets, resulting in conflict of vehicular and pedestrian traffic. At study route, the number of street vendors was large and makes walking very complex. Photos and figure below illustrates the problems graphically and physically.

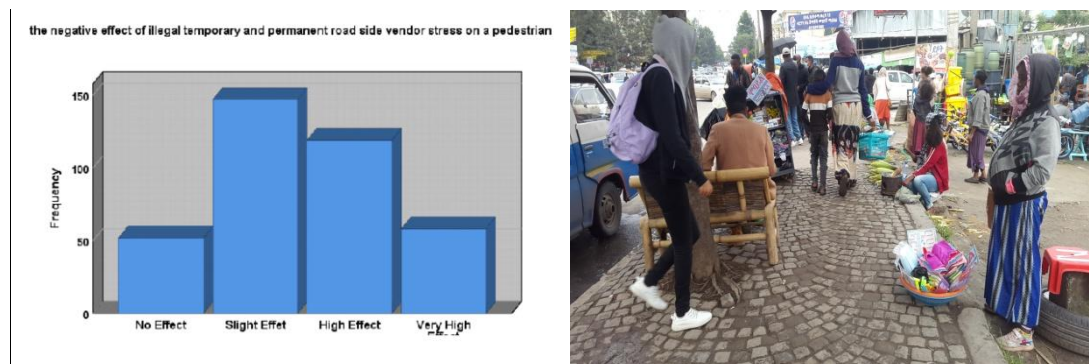


Figure 4. 11 Road vendor stress on pedestrian

4.5.4 Pedestrian Pathway uses for Street parking and car wash

The presence of vehicles in the pedestrian environment enforces pedestrians to encroach into the main carriageways, conflicting moving vehicles and pedestrians. In the figure: The study area also shows the illegal parking of vehicles. In this particular study, assessments were done by categorizing on-street parking as temporary parking and car washing on pedestrian walkway environments. Even though some pedestrian walkways are paved with cobblestones, the car wash on pedestrian walkways damages the environment and affects the movement of pedestrians permanently, as shown in the

figure below. In the study area, temporary on-street parking is legally allowed, although this action adversely impacts pedestrian movements. As shown in the figure below, there is pedestrian movement impact due to the pathway used for car wash on pedestrian walkways and that temporarily parked on the street, 67.3 % cannot be affected and 32.7% can be affected. Totally, the survey results showed that there was car wash on pedestrian environments and that the impact of temporarily parking on the streets was also bad. Hence, appropriate action should be taken to ban temporary parking.



Figure 4. 12. Street parking and car wash Pedestrian Pathway

Source: Field survey

pedestrian pathway uses for other function

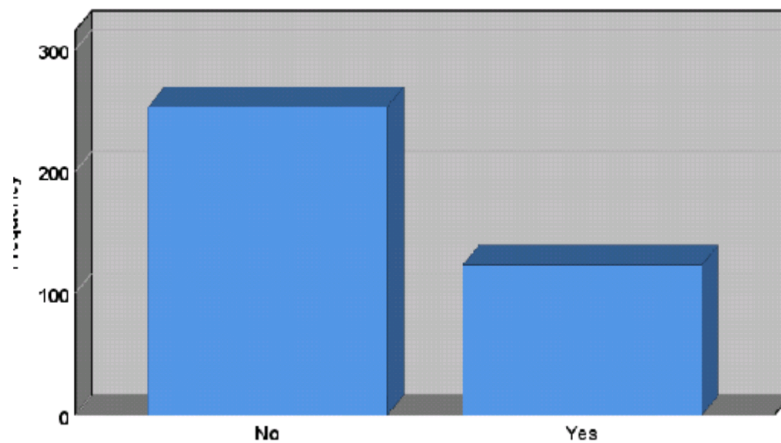


Figure 4. 13 Pedestrian Pathway used for another function

4.5.5 Drainage Problems

The quality of footpaths and other facilities for pedestrians influences the decision to walk. The particular factors identified in this study were: cleanliness, including the presence of litter, rubbish and the condition of the pavement. In a research on drainage on roads, Toryila (2016) stated that well-designed and well-maintained road drainage is important to minimize the environmental impact of road runoff on receiving water environment, ensure the speedy removal of surface water to enhance safety and minimize disruption to road users, and to maximize the longevity of the road surface and associated pedestrian infrastructure. Poor drainage causes early pavement distress, leading to driving problems and structural failures of roadside infrastructure. In this study, the effects of poor drainage on pedestrian walking convenience and network were assessed and analyzed in respect of low, medium, high, and very high conditions, and the results were 19.7%, 37.5%, 28.5%, and 14.4% respectively.

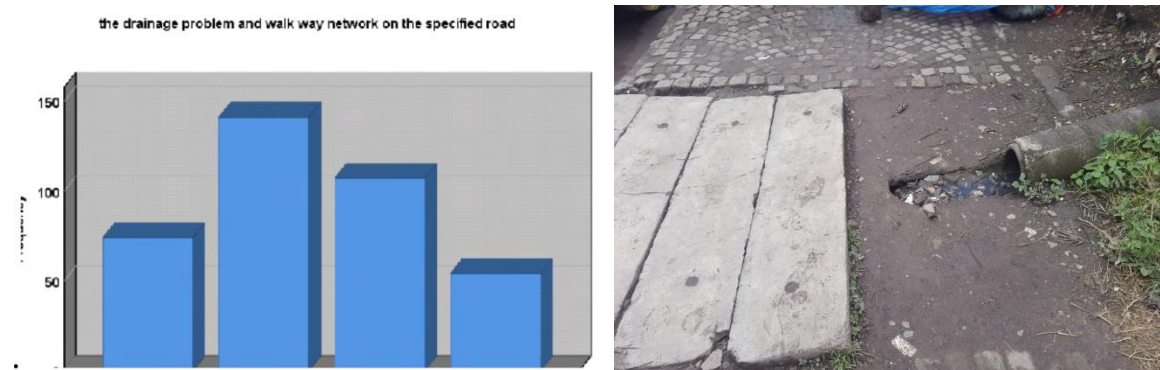


Figure 4. 14. Drainage condition

Source: Field survey

4.6 Results of factors affecting Pedestrian Safety

4.6.1 Obstructions

The quality of services provided is measured in terms of the effective walkway width. The effective walkway width is the free walkway width that accommodates pedestrians. Addis Ababa city Transport Planning and Management Office (2016), defines effective walkway width as the difference between the total walkway width and the shy, fixed area and obstacles. The effective walkway widths were reduced by different obstructions, like;

wrong set of trees, poles on pedestrian walkways, dust bins on pedestrian walkways, on-street parking, on-street vendors' activities, grass and weed growing on pedestrian walkways, poor drainage facilities, and improperly placed roadside infrastructure (lack of road amenities).

Thus, to assess the impact of obstructions on pedestrian safety and comfort, and to provide a safe, comfortable, and pleasant pedestrian pathway, these factors must be taken into consideration. Accordingly, the survey results are presented in the figure below illustrating the presence of wrong set tree, pole on pedestrian walkway, and dust bin on pedestrian walkway. The figure below illustrates the adverse impact of different obstructions on pedestrian safety and comfort.



Figure 4. 15. Obstructions

Source: Field survey

4.6.2 Pedestrian safety

Each year, more than 270, 000 pedestrians lose their lives on the world's roads. Many leave their homes as they would on any given day, never to return. Globally, pedestrians constitute 22% of all road traffic fatalities, and in some countries, this proportion is as high as two thirds of all road traffic deaths. Millions of pedestrians are non-fatally injured, some of whom are left with permanent disabilities. These incidents cause much suffering and grief as well as economic hardship (*WHO, 2013*).

The capacity to respond to pedestrian safety is an important component of efforts to prevent road traffic injuries. Pedestrian collisions, like other road traffic crashes, should

not be accepted as inevitable because they are both predictable and preventable. The key risks to pedestrians are: driver behaviour, particularly in terms of speeding and drinking and driving; infrastructure, in terms of a lack of dedicated facilities for pedestrians such as sidewalks, raised crosswalks, and medians; and vehicle design, in terms of solid vehicle fronts which are not forgiving to pedestrians should they be struck.

The collisions cause includes the role of the driver (s), pedestrians, vehicle (s), roadway and the environment. The results from accident reconstructions are useful in developing recommendations for improving road safety, transport infrastructure and safety aspects of motor vehicle designs.

4.6.3 Pedestrian Behavior

The personal assessment is based on the user's perception rating of the service quality of pedestrian facilities. User perceptions toward the operation of pedestrian facilities are of great importance to such an evaluation process. This type of survey is conducted among pedestrians to understand the feelings of users while walking at the study locations. Pedestrians themselves are the most appropriate group to identify treatments that create a safe and desirable environment for them and options that increase their likelihood of using the walker at designated facilities correctly.

To investigate the impact of pedestrian behavior on pedestrian safety, pedestrians careless, reckless or in a hurry, and pedestrians entering a carriageway without due care were used.

4.6.4 Motorist Behavior

Motorists' yielding behavior is influenced by the location of the pedestrian. According to Davis and Hallenbeck (2008), vehicle yielding behavior will change depending on pedestrian standing location, that is, on the shoulder or sidewalk or in the center turn lane. In this study, in addition to the pedestrian questionnaire, five drivers were also asked to share their perceptions of the existing road conditions and the way pedestrians act when walking and crossing the roads. All of the respondents strongly agreed that vehicle yielding is directly influenced by the visibility of the crossings. They also stated that not

all pedestrians act in a good manner when crossing the roads, and more pedestrians walk on the main carriageway, responding to bad actions by drivers, especially when street water splashes on them. The drivers stated, "The carriageway surface conditions were poor, the narrow carriageway width, and the invisibility of pedestrian crossing areas and street vendors were the main problems that made drivers not drive safely". To investigate the impact of motorist behavior on pedestrian safety, Behavior of driver towards pedestrian and Behavior of driver towards road conditions were used.

4.7 Test of Normality

There are many parametric statistical methods, such as: analysis of variance or ANOVA test, discriminate analysis, linear regression, Pearson correlation, f-test and t-test. They require that the dependent variable be approximately normally distributed for each category of the dependent variable.

The following numerical and visual outputs can be investigated: skewness and kurtosis Z-value:-that should be somewhere in the span of -1.96 to +1.96, The Shapiro-wilk test p-value should be greater than 0.05 and the histogram, normal Q-Q plot, and box plots should visually indicate that the data is approximately normally distributed.

The skewness and kurtosis measures should be as close to zero as possible. Because a small departure from zero is therefore no problem, as long as the measure is not too large compared to this standard error.

Table 4. 2. Test of Normality

Test Of Normality Obstructions(Ob)						
NO			Yes			
	Statistic	Std. Error	Z-Value	Statistic	Std. Error	Z-Value
Skewness	0.170	0.168	1.010488	0.232	0.188	1.231938
Kurtosis	-0.350	0.334	-1.0477	-0.443	0.375	-1.18096
Pedestrian Accident(PA)						
NO			Yes			
	Statistic	Std. Error	Z-Value	Statistic	Std. Error	Z-Value
Skewness	0.170	0.168	1.010488	0.232	0.188	1.231938
Kurtosis	-0.350	0.334	-1.0477	-0.443	0.375	-1.18096
Pedestrian Behavior (PB)						
NO			Yes			
	Statistic	Std. Error	Z-Value	Statistic	Std. Error	Z-Value
Skewness	0.170	0.168	1.010488	0.232	0.188	1.231938
Kurtosis	-0.350	0.334	-1.0477	-0.443	0.375	-1.18096
Motorist Behavior (MB)						
NO			Yes			
	Statistic	Std. Error	Z-Value	Statistic	Std. Error	Z-Value
Skewness	0.170	0.168	1.010488	0.232	0.188	1.231938
Kurtosis	-0.350	0.334	-1.0477	-0.443	0.375	-1.18096

Source: Authors survey result

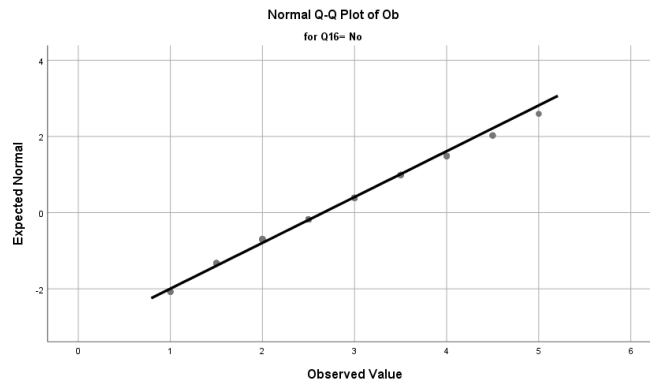
Table 4. 3 Test of Kolmogorov-Smirnov and Shapiro-Wilk

Tests of Normality							
	pedestrian and pathway safety	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Ob	No	.135	210	.000	.961	210	.000
	Yes	.140	166	.000	.961	166	.000
PA	No	.143	210	.000	.954	210	.000
	Yes	.141	166	.000	.957	166	.000
PB	No	.130	210	.000	.960	210	.000
	Yes	.154	166	.000	.944	166	.000
MB	No	.136	210	.000	.947	210	.000
	Yes	.121	166	.000	.960	166	.000

a. Lilliefors Significance Correction

Source: Authors survey result

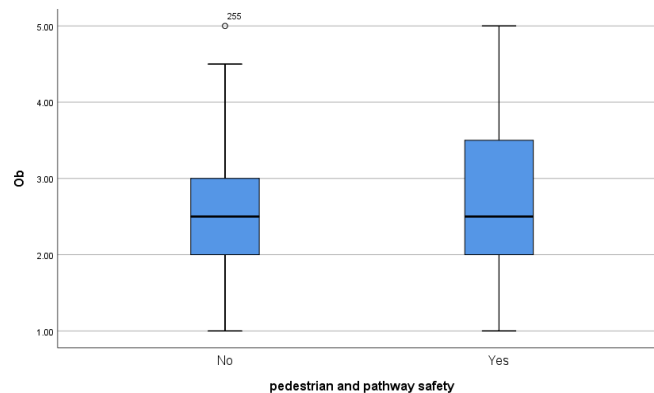
Sample Normal Q-Q Plot



Graph 4. 1 Normal Q-Q Plot

Source: Authors survey result

Sample of Box Plot



Graph 4. 2 Box Plot

4.8 Measurement of correlation

This analysis is to answer the question about the possible relationship between the variables "Pedestrian and Pathway Safety" and "Obstruction (Ob), Pedestrian Accident (PA), Pedestrian Behavior (PB) and Motorist Behavior (MB)"

The first thing we would do is locate the cell where the variables of interest intersect. "Pedestrian and Pathway Safety" is the independent variable, and the dependent variables

are "Obstruction (Ob), Pedestrian Accident (PA), Pedestrian Behavior (PB) and Motorist Behavior (MB)." Therefore, actually there are four related questions:

1. What was the relationship between "Pedestrian and Pathway Safety" and "Obstruction (Ob)"? (the light blue cell);
2. What was the relationship between "Pedestrian and Pathway Safety" and "Pedestrian Accident (PA)"? (the Yellow cell);
3. What was the relationship between "Pedestrian and Pathway Safety" and "Pedestrian Behavior (PB)"? (the light green cell) and
4. What was the relationship between "Pedestrian and Pathway Safety" and "Motorist Behavior (MB)"? (the tan cell);

SPSS correlation table cells always contain at least 3 pieces of information: First, the size of the correlation (the "r" statistic), which has a range between -1 (perfect negative correlation) and 1 (perfect positive correlation). If the correlation is "statistically significant", SPSS also flags this number with either a (*) [significant at least at the .05 level] or (**) [significant at least at the .01 level]. If the correlation statistic doesn't have a minus in front of it, which means that the correlation is positive, which means that high scores for both variables go together, and low scores for both variables go together. If the correlation statistic had a minus in front of it, that would mean that as the values of one variable go up, the values of the other variable go down (i.e., a negative or inverse correlation). Second, the level of significance of the correlation (a level of .05 or smaller is considered "statistically significant". So, the following levels of significance are increasingly smaller, and thus more statistically significant. The last information is the number of subjects that were considered in this particular test.

So, in this case, the light blue cell (relationship between "Pedestrian and Pathway Safety" and "Obstruction (Ob)") shows that there was a positive correlation of 0.005 between "Pedestrian and Pathway Safety" and "Obstruction (Ob)" (i.e., "Pedestrian and Pathway Safety" has a weak relationship with "Obstruction (Ob)", and that this relationship was statistically not significant at the 0.919 level. The yellow cell (relation of "Pedestrian and Pathway Safety" and "Pedestrian Accident (PA)") shows that there is a negative

correlation of -0.07 between "Pedestrian and Pathway Safety" and "Pedestrian Accident (PA)" and that this relationship was statistically significant at the 0.176 level. The results show that pedestrian and pathway safety has a weak relationship with Pedestrian Accidents (PA). The light green cell (relationship between "Pedestrian and Pathway Safety" and "Pedestrian Behavior (PB)") shows that there was a negative correlation of -0.076 between "Pedestrian and Pathway Safety" and "Pedestrian Behavior (PB)" and that this relationship was statistically significant at the 0.14 level. The results show that pedestrian and pathway safety has a weak relationship with pedestrian behavior (PB). The last case, the tan cell (relationship between "Pedestrian and Pathway Safety" and "Motorist Behavior (MB)") shows that there was a positive correlation of 0.043 between "Pedestrian and Pathway Safety" and "Motorist Behavior (MB)" and that this relationship was statistically significant at the 0.405 level. The results show that pedestrian and pathway safety has a relationship with motorist behavior (MB).

Table 4. 4 Correlation

		Correlations				
		pedestrian and pathway safety	Ob	PA	PB	MB
pedestrian and pathway safety	Pearson Correlation	1	.005	-.070	-.076	.043
	Sig. (2-tailed)		.919	.176	.140	.405
	N	376	376	376	376	376
Ob	Pearson Correlation	.005	1	.151**	.156**	.052
	Sig. (2-tailed)	.919		.003	.002	.315
	N	376	376	376	376	376
PA	Pearson Correlation	-.070	.151**	1	.072	.027
	Sig. (2-tailed)	.176	.003		.166	.608
	N	376	376	376	376	376
PB	Pearson Correlation	-.076	.156**	.072	1	-.056
	Sig. (2-tailed)	.140	.002	.166		.281
	N	376	376	376	376	376
MB	Pearson Correlation	.043	.052	.027	-.056	1
	Sig. (2-tailed)	.405	.315	.608	.281	
	N	376	376	376	376	376

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Authors survey result

4.9 Analysis of Performance of Pedestrian Level of Service

4.9.1 General PLOS determination

Level of service determination is a quantitative measure used to measure the quality of service from a user's perspective. Qualitative criteria defined by Milazzo include:

Qualitative Measures of Pedestrian Flow

- ✓ Freedom to choose desired speeds
- ✓ Freedom to pass slower pedestrians
- ✓ Ability to cross a stream of pedestrians
- ✓ Ability to walk in the reverse direction of a stream of pedestrians
- ✓ Ability to maneuver without conflicts
- ✓ Delay at signalized intersections
- ✓ Delay at un-signalized intersections

Pedestrians' movements are restricted by the physical boundaries around them, such as the presence of walkways or pedestrian ways. Therefore, the needs of pedestrians should be considered in the design of transportation facilities. These facilities should be pedestrian friendly to promote walking and the safety of pedestrians.

To know how pedestrian-friendly it is, it becomes necessary to assess the walking ability conditions. Such a measure of walking conditions would be helpful on pedestrian pathways and estimation of PLoS is the most common approach to assessing the quality of operations of pedestrian facilities.

The pedestrian level of service may possibly be determined by using two major methods: quantitative and qualitative. Quantitative pedestrian level of service more focuses on the number of pedestrians and the dimensions of pedestrian walkway infrastructure facilities. Therefore, the qualitative measure of pedestrian traffic flow along with environmental factors that might affect the perceived level of comfort, convenience, safety, security, and the economy of the walkway system are determined in terms of the percent of modal conflicts between different modes.

4.9.2 Factors affecting PLoS

Obstructions are objects or others that create obstacles to the safe movement of pedestrians. Obstructions tend to influence pedestrian movement and reduce the effective walkway width. Therefore, the assessment of obstructions is essential to determine the access available to pedestrians.

Table 4. 5. Obstruction characteristics and elements of pedestrians

No	The characteristics of obstruction		Quantity	No. of problems that be seen	Reasons that the problems appear	Remark
1	Street light pole, Tele pole, Electric pole		189	42	The poles are set at the center of pedestrian pathway	
2	Advertising sign	Overhead hanging	20	4	Overhead hanging at the center of pedestrian pathway	
		Not over head hanging	7	3	Three of them are at the center of pedestrian pathway	
3	Plant/Tree		228	114	The trees are planted at the center of pedestrian pathway	
4	Bollard		20	20	All are not set with a standard	
5	Shop awning		99	51	The awning are put and set at the pedestrian pathway to get a vision from their customer	
6	Drainage		107	43	In the drainage system, some manholes are broken, open, dumped by dry waste, and the ditches too.	
7	Under construction				Some parts (around imperial hotel) pedestrian pathway are under construction	
8	Shoe shine bench		23	16	Some of shoe shine benches set at the center of pedestrian pathway	
9	Garbage through box		40	31	Most garbage through boxes are set at the center of pedestrian pathway and some of them are broken and leave at the walk way	
10	Ramp				No ramp at all	
12	Crossing surface		6	3	No ramp at Crossing surface and not visible	
13	Tele box		1	1	Tele box are set at pedestrian pathway	
14	Generator		1	1	Generator are set at pedestrian pathway	

Source: Authors survey result

4.9.3 Pedestrian Level of Service (PLOS)

PLOS categories are labeled A to F on the basis of average pedestrian space (AP), flow rate (VP) and volume to capacity ratios (V/C). The PLOS ranges defined in this study are adopted from HCM (2010).

Table 4. 6 Pedestrian levels of service boundaries on sidewalk

LOS	Speed (m/min)	Unit width flow rate (ped/min/m)	Space (m ² /ped)	v/c ratio
A	> 78	≤ 16	> 5.6	≤ 0.21
B	> 76 – 78	> 16 – 23	> 3.7 – 5.6	> 0.21 – 0.31
C	> 73 – 76	> 23 – 33	> 2.2 – 3.7	> 0.31 – 0.44
D	> 68 – 73	> 33 – 49	> 1.4 – 2.2	> 0.44 – 0.65
E	> 45 – 68	> 49 – 75	> 0.75 – 1.4	> 0.65 – 1.00
F	≤ 45	varies	≤ 0.75	varies

Source: HCM 2010

Understanding fundamental relationships between flow-speed-density is a significant issue in the designing and planning of pedestrian facilities. The shape of these relationships basically depends on flow conditions, type of facility and pedestrian characteristics such as behavior, age, gender, and number of pedestrians walking.

The level of service of the facilities was computed by taking into account the volume of pedestrians walking using pedestrian pathways in the locations of pedestrian location one (P1), pedestrian location two (P2) and pedestrian location three (P3) using the two corridors of the street within a 20m range of distance.

4.9.3.1 PLOS Based on Flow Rate (VP)

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

1. The volume of pedestrians every 15-minutes of the peak period was counted manually for three weekdays each day for 8-hours from 8:00AM-12:00PM in the morning and 2:00PM-6:00PM in the afternoon were conducted and labeled as D-

1, D-2, and D-3 at each site. The Manual counts pedestrians passing, entering and leaving the pathway within a 20m distance.

2. The peak 15-minute volume was observed and dividing it by the effective width of the facility gives the flow per meter. This flow value per minute gives the flow rate in pedestrians/minutes/meters.

$$V_P = \frac{V_{15}}{15 \times W_E}$$

Where: V_P = pedestrian flow rate (p/min/m), = peak 15-minute flow rate (p/15-min), and W_E = effective width (Effective width= available width after subtracting shy distance and fixed objects). The total width (W_T) of the pedestrian pathway was measured from the face of the building to the curb stone and found to be 2.30m. The effective width (W_E) was also measured in the field by leaving out shy distance (buffer that pedestrians give themselves to avoid accidentally stepping off the curb, brushing against a building's face, or getting too close to other pedestrians standing under awnings or window shopping). The Imperial Hotel (P1) direction of AB = 1.26m, BA = 1.13m, Taxi Tera (P2) direction of CD = 1.15m, DC = 1.20m, and Gerji Roba Bakery (P3) direction of EF = 1.36m, FE = 1.36m, and And the distance from P1 to P2 is 1287.48m, from P2 to P3 is 643.738m.

Table 4. 7. Sidewalks width

Pedestrian location	Direction	Average Effective area of side walk(m ²)	Average Effective width of sidewalks(m)
P1	AB	46	1.26
	BA	46	2.13
P2	CD	46	1.15
	DC	46	1.2
P3	EF	46	1.36
	FE	46	1.27

Source: own source

Table 4. 8 Volume of Pedestrians during the Peak and Off-Peak Periods

Pedestrian location	Days	Direction	15 minute Volume			
			Morning		Afternoon	
			Peak	Off-peak	Peak	Off-peak
Imperial Hotel(P1)	D-1	AB	548	100	382	75
		BA	536	94	281	64
	D-2	AB	557#	112	451#	86#
		BA	553*	124*	436*	89*
	D-3	AB	556	125#	436	80
		BA	543	121	420	72
Taxi Tera (P2)	D-1	CD	839#	102#	531	80
		DC	729*	100	423*	74
	D-2	CD	832	98	537#	80
		DC	710	102*	403	74
	D-3	CD	822	97	486	84#
		DC	721	91	413	76*
Gerji Roba (P3)	D-1	EF	914#	127#	617#	94#
		FE	927*	112	626	90*
	D2	EF	913	100	611	86
		FE	876	94	641*	82
	D-3	EF	910	110	597	86
		FE	889	131*	567	82

Source: own source

Note: “#” Indicates that the highest pedestrians flow in each site location from Imperial Hotel to Gerji Roba in the left walkway.

“*” indicates that the highest pedestrians flow in each site location from Imperial Hotel to Gerji Roba in the left walkway.

Sample calculation of pedestrian unit flow rate and LOS for Imperial Hotel pedestrian location (P1) in the direction of AB for the morning peak period is illustrated below. The peak 15-minute volumes were 548 at Day-1, 557 at Day-2 and 556 at Day-3 count. Hence, for analysis purpose the maximum peak 15-minute volume in the morning peak period (V_{15}) = 557 (from Day-2 count) Effective width of the walkway (W_E) = 1.26m.

$$V_P = \frac{V_{15}}{15 \times W_E} = \frac{557p}{15min \times 1.26m} = 29.47p/min/m \approx 30p/min/m$$

A flow rate of 30p/min/m is classified as a PLOS-C from the HCM2010 level of service criteria tables. 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 walkways falls into the category of PLOS-C and D in pick hour and all fall into category PLOS-A in off-pick hour. The result shows that pedestrians move at a moderate pace at pick-up hour, and at off-pick hour, pedestrians move along desired paths, select walking speeds freely and conflicts between pedestrians are unlikely.

Table 4. 9. Level of service of flow rate at pick and off-pick hour

Pedestrian location	Direction	15 minute Volume, Flow rate (V_P) values and PLOS	15 minute Volume			
			Morning		Afternoon	
			Peak	Off-peak	Peak	Off-peak
Imperial Hotel (P1)	AB	Pedestrian count	557	125	451	86
		VP	30	7	24	5
		PLOS	C	A	C	A
	BA	Pedestrian count	553	124	436	89
		VP	33	8	26	6
		PLOS	C	A	C	A
Taxi Tera (P2)	CD	Pedestrian count	839	102	537	84
		VP	49	6	32	5
		PLOS	D	A	C	A
	DC	Pedestrian count	729	102	423	76
		VP	40	6	24	5
		PLOS	D	A	C	A
Gerji Roba (P3)	EF	Pedestrian count	914	127	617	94
		VP	44	7	30	5
		PLOS	D	A	C	A
	FE	Pedestrian count	927	131	641	90
		VP	49	7	34	5
		PLOS	D	A	C	A

Source: own source

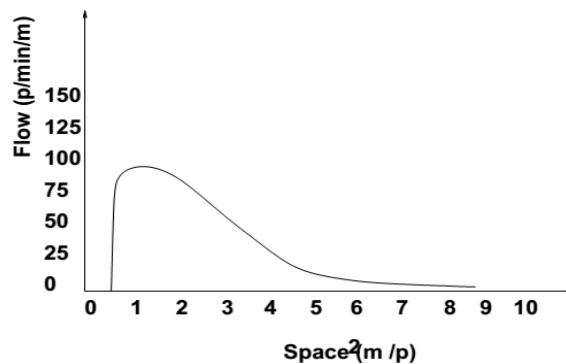
4.9.3.2 PLOS Based on Average Pedestrian Space (AP)

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 0.3m² is used as the basic space for a single pedestrian as this represents the practical minimum for standing pedestrians. In evaluating pedestrian facilities, an area of 0.75 m² is used as the buffer zone for each pedestrian (HCM2010).

$$A_P = \frac{S_P}{V_P}$$

Where: A_P = Peds. Space (m²/p), S_P = Peds. Speed (m/min), and V_P = pedestrian flow per unit width (p/m/minutes).

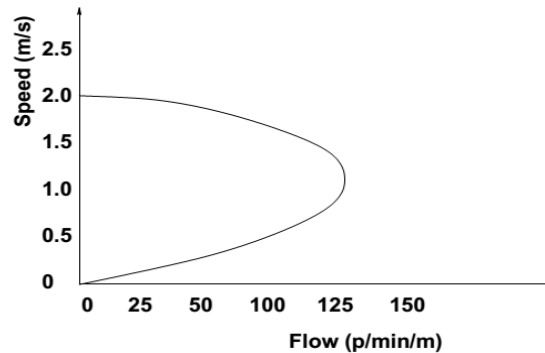
The basic relationship between flow and space, recorded by several researchers, is illustrated in the Fig. capacity of the walkway facility. From Fig., it is apparent that all observations of maximum unit flow fall within a narrow range of density, with the average space per pedestrian varying between 0.4 and 0.9 m²/p. Even the outer range of these observations indicates that maximum flow occurs at this density, although the actual flow in this study is considerably higher than in the others. As space is reduced to less than 0.4 m²/p the flow rate declines precipitously. All movement effectively stops at the minimum space allocation of 0.2m²/p to 0.3 m²/p (Dr. Tom V. Mathew, 2014).



Graph 4. 3. Relationship of flow and space

PLOS for the pedestrian pathway was computed by considering the speed. The relationship between pedestrian speed and flow shows that when there are few

pedestrians on a walkway, as flow increases, speeds decline because of closer interactions among pedestrians. When a critical level of crowding occurs, movement becomes more difficult, and both flow and speed decline.



Graph 4. 4. Relationship of flow and space

It recommends a pedestrian walking speed of 1.2 m/sec for most conditions for the young aged, consistent with Chapter 13, Pedestrians, of the Highway Capacity Manual 2010 from several sources. In areas with large numbers of older pedestrians, the recommend a walking speed of 1.0 m/s, a nearly 30% decrease from current HCM values. The question may arise, "What constitutes large numbers of older pedestrians?" A suggested answer is, "large numbers of older pedestrians exist when the elderly proportion begins to materially affect the overall speed distribution at the facility."

Table 4. 10. Pedestrian speed value

Pedestrian location	Direction	Pedestrian Speed (meter/minutes)
P1	AB	70.8
	BA	69
P2	CD	56.4
	DC	66.6
P3	EF	58.8
	FE	56.4

Source: own source

Sample calculation of average pedestrian space is illustrated below for pedestrian location one (P1) of direction AB, Speed of pedestrians 70.8m/min, Flow rate in the morning peak period 30p/m/min

$A_P = \frac{S_P}{V_P} = \frac{70.8\text{m/min}}{30\text{p/m/min}} = 2.36\text{m}^2/\text{p}$, and classified as a PLOS-C from HCM2010 level of service criteria tables

Table 4. 11. Level of service of pedestrian space at pick and off-pick hour

Pedestrian location	Direction	15 minute Volume, Flow rate (V_P) values and PLOS	15 minute Volume			
			Morning		Afternoon	
			Peak	Off-peak	Peak	Off-peak
Imperial Hotel (P1)	AB	Pedestrian count	557	125	451	86
		VP	30	7	24	5
		AP	2.36	10.114285	2.95	14.16
		PLOS	C	A	C	A
	BA	Pedestrian count	553	124	436	89
		VP	33	8	26	6
		AP	2.090909	8.625	2.653846	11.5
		PLOS	D	A	C	A
Taxi Tera (P2)	CD	Pedestrian count	839	102	537	84
		VP	49	6	32	5
		AP	1.15102	9.4	1.7625	11.28
		PLOS	E	A	D	A
	DC	Pedestrian count	729	102	423	76
		VP	40	6	24	5
		AP	1.665	11.1	2.775	13.32
		PLOS	D	A	C	A
Gerji Roba (P3)	EF	Pedestrian count	914	127	617	94
		VP	44	7	30	5
		AP	1.336364	8.4	1.96	11.76
		PLOS	E	A	D	A
	FE	Pedestrian count	927	131	641	90
		VP	49	7	34	5
		AP	1.15102	8.0571428	1.658824	11.28
		PLOS	E	A	D	A

Source: own source

To see if the distraction of pedestrians within a 20m range had any effect on the LOS of the pedestrian pathway, PLOS was calculated based on the average pedestrian space of pedestrians. The PLOS analysis was computed based on flow rate values and pedestrian speeds. In the morning peak period, the average pedestrian space along Taxi Tera,

direction CD, and Gerji Roba Bakery in both directions (EF & FE) fell to an average pedestrian space of $0.75\text{m}^2/\text{p}$ - $1.4\text{m}^2/\text{p}$ and the LOS, which is categorized as PLOS-E. In the afternoon peak period, the average pedestrian space along P1, P2 & P3 LOS, which is categorized as PLOS-C and PLOS-D, is a moderate average pedestrian space. At off-pick hour, all fall into the category of PLOS-A. The PLOS of the facilities computed by considering pedestrians remained the same even after pedestrians within a 20m range of distance are considered. The facilities, in general, provide inadequate pedestrian space categorized as PLOS-E, moderately adequate in PLOS-C or PLOS-D when pedestrians within a 20m range of distance are considered for the analysis of pedestrian locations. Therefore, the pedestrian walkway along the study does not fulfill the requirements at pick up hour of a basic area for standing pedestrians (0.3 m^2) and an area used to evaluate pedestrian facilities (0.75m^2) as a buffer zone for each pedestrian specified in HCM2010.

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

For determination of the PLOS category of off-street pedestrian facility, volume to capacity (v/c) ratio is one of the most important factors. For this study, pedestrian hourly volume can be found from video data collection and the capacity of side-walks has been taken from IRC: 103-1988. The width of the side-walk for 1.5m, 2m, 2.5m, 3m and 4m capacities in number of people per hour in both directions are 800, 1600, 2400, 3200 and 4000 respectively.

The volume to capacity ratio (V/C) of the pedestrians along the study route was computed by dividing the flow rate values by 75ped/min/m for the walkway and as per the HCM2010. A sample calculation of the volume to capacity ratio (V/C) for the Imperial Hotel (P1) in the morning peak period is computed as follows.

Flow rate in the morning peak = 29.47ped/min/m

Capacity of pedestrian pathway= 75ped/min/m (from HCM2010)

$$V/C = \frac{V_p}{C}$$

Where, V/C = Volume capacity ratio, V_p = Flow rate and C= capacity of pedestrian walk way,

$$V/C = \frac{V_p}{C} = \frac{29.47 \text{ p/min/m}}{75 \text{ p/min/m}} = 0.3929$$

Table 4. 12. Level of service of volume capacity ratio at pick and off-pick hour

Pedestrian location	Direction	15 minute Volume, Flow rate (V_p) values and PLOS	15 minute Volume			
			Morning		Afternoon	
			Peak	Off-peak	Peak	Off-peak
Imperial Hotel (P1)	AB	Pedestrian count	557	125	451	86
		VP	30	7	24	5
		V/C	0.4	0.093333	0.32	0.066667
		PLOS	C	A	C	A
	BA	Pedestrian count	553	124	436	89
		VP	33	8	26	6
		V/C	0.44	0.106667	0.346667	0.08
		PLOS	C	A	C	A
Taxi Tera (P2)	CD	Pedestrian count	839	102	537	84
		VP	49	6	32	5
		V/C	0.653333	0.08	0.426667	0.066667
		PLOS	E	A	C	A
	DC	Pedestrian count	729	102	423	76
		VP	40	6	24	5
		V/C	0.533333	0.08	0.32	0.066667
		PLOS	D	A	C	A
Gerji Roba (P3)	EF	Pedestrian count	914	127	617	94
		VP	44	7	30	5
		V/C	0.586667	0.093333	0.4	0.066667
		PLOS	D	A	C	A
	FE	Pedestrian count	927	131	641	90
		VP	49	7	34	5
		V/C	0.653333	0.093333	0.453333	0.066667
		PLOS	E	A	D	A

Source: own source

The V/C ratio of the pedestrian pathway was also computed by considering pedestrians within a 20m range of distance. The pedestrian walkway demand at P2 and P3 of directions CD and FE morning pick hours respectively is higher as compared to the other pedestrian walkways along the study, which resulted in the highest V/C ratio. The others

pick hours in the morning and afternoon. The results of PLOS fall into PLOS-c and PLOS-D. As far as the PLOS of the pedestrian pathway at off-pick hours of morning and afternoon fall all categorized as 'A', the capacity of some parts needs improvement, while others are moderate to serve pedestrians.

Three parameters, which include flow rate (VP), pedestrian space (AP) and volume to capacity (V/C) ratios, were considered to classify the P-LOS of the pedestrian pathway facilities along the study pathway. The result shows that the facilities can accommodate pedestrians with PLOS-C and D, but some parts fall to E at both morning and afternoon pick-up hours, and at off-pick hours, all fall to PLOS-A. The results imply that the pedestrian pathway is good enough to serve all pedestrians.

5 Chapter Five: Discussion and summary of Findings

5.1. Pedestrian environmental effect of analysis

The pedestrian environment is mostly taken up by the condition of walkways. Barriers or obstacles like spoil and junk material, narrow width and the complete absence of walkways cause walkway modal conflict and significantly reduce the safety of pedestrians. Inappropriate and dangerous pedestrian walkways, especially around Taxi Tera, are completely used for parking and totally obstruct the movement of disabled and not-disabled people. Poles, plants, temporary vendors, are also obstacles for pedestrians.

5.2 Pedestrian safety and infrastructure effect analysis

The existing pedestrian pathways were generally taken up by sidewalk presence and continuity, sidewalk quality and maintenance, slopes and curbs, and temporary obstacles on sidewalks, like roadside vending, shoe shine benches, advertising signs, etc. Mostly, pedestrians don't want to walk on sidewalks, even if sidewalks are available. Because of the above obstacles, pedestrians like to share the road with cars. But, it is legally forbidden in Ethiopia by the traffic law of the Road Transport Traffic Control Council of Ministers (Amendment) in a Regulation of No. 395/2017 23rd year No.8 Addis Ababa, 3rd January 2017 and explained, "Pedestrians can't walk on the road when there is a sidewalk available."

Traffic accidents are known to be one of the major transportation problems due to the congestion of traffic that comes from the inadequacy of sidewalk width. The availability of pedestrian facilities and the adequacies of road amenities were very bad and bad respectively, and there was also a lack of public toilets, passenger or pedestrian sheds. The results confirm that roadside vendors, lack of walkway maintenance and on-street parking. Pedestrians use carriageways instead because the walkways are not wide enough during the peak hours and the surface of the walkways is damaged.

5.3 Factor affecting pedestrian safety

The result of the analysis showed that there were sidewalk segments that were not functional, accessible, and comfortable for the disabled and not disabled people. The reasons for inaccessible segments are the existence of steep curbs, open and dirty drainage, illegal parking and washing of cars, temporary and permanent roadside vendors, and improperly placed advertising signs, plants, electric poles... etc.

Drivers complained that the carriageway surface conditions were poor due to substandard maintenance, narrow and invisibility of pedestrian crossing areas, the availability of roadside vendors and the total absence of street furniture. They complained that not all pedestrians act in a good manner while crossing roads and they walk on main carriageways. There is also bad behavior; attitude and drunk drivers show bad actions.

The results of this study showed that accidents involving pedestrians occurred when they were crossing the street. In this observation, the crossing zebra lines were faded and there was no ramp at the connection between the zebra cross and the walkway. Pedestrians complained about the lack of furniture separating motorized and non-motorized means of transportation and the quality of the walkway surface.

The study results confirmed that there is poor environmental sanitation, largely arising from littering of the sidewalks and dumping of garbage into open drains. Moreover, most of the respondents agreed that the drainage facilities in the study area were very poor.

5.4. Effect of performance of pedestrian level of service

As it is clearly seen from the analysis of the HCM 2010 adaptation procedures in pedestrian pathways, both the average hourly pedestrian volume count associated with the existing infrastructure parameters. Thus, the output of the result concludes that the sidewalks are currently serving near to capacity with the pick-up hours of the morning and afternoon Level of Service (LOS) of C and D, and at off-pick hours at capacity with the overall Level of Service (LOS) of A. The flow rate of pick-up hours at Imperial Hotel (P1) is between 23p/min/m and 33p/min/m and LOS of C, and at the other two locations is between 33p/min/m and 49p/min/m. In the afternoon, all locations lie on the LOS of C.

pedestrian space of the LOS In the morning peak period, the average pedestrian space along Taxi Tera, direction CD, and Gerji Roba Bakery in both directions (EF & FE) fell to an average pedestrian space of $0.75\text{m}^2/\text{p}$ - $1.4\text{m}^2/\text{p}$ and the LOS, which is categorized as PLOS-E. In the afternoon peak period, the average pedestrian space along P1, P2 & P3 LOS, which is categorized as PLOS-C and PLOS-D, is a moderate average pedestrian space. At off-pick hour, all fall into the category of PLOS-A. The volume capacity ratio of LOS allover pick hours of morning and afternoon results of PLOS falls to PLOS-c and PLOS-D except pedestrian locations of P2 and P3 of directions CD and FE morning pick hours respectively are higher as compared to other pedestrian walkways along the study, which resulted in the highest V/C ratio?

6 Chapter Six: Conclusions and Recommendations

6.1. Conclusions

For safety and comfort purposes, pedestrians need facilities that are safe, attractive, convenient, and easy to use, especially appropriate walking facilities everywhere. Poor design of pedestrian facilities can lead to endless problems and can discourage pedestrians due to a feeling of unselfishness, unprotected, or uncomfortable. So, the needs of pedestrians should be considered in the design of urban environments and transportation facilities.

The pedestrian pathways were mostly in use for parking and roadside vending. The pedestrian conflict with other modes and the conflict between pedestrians were found in bad conditions. The results of the study prove that roadside vendors, the absence of pedestrian pathway improvement, and car wash and parking on the pathway were the major causes of conflict between pedestrians and other modes. Pedestrians use carriageways instead because the pathway widths are not adequate during the peak hours. The surface of the pathways was completely damaged and some parts were not used by the disabled.

The results suggest that the effect of the pedestrian walking environment on any urban road segment, like the footpath and different pedestrian facilities, is affected by obstacles, lack of road amenities, absence of street furniture,... etc, that decrease pedestrian safety.

The study results show that there were a high number of pedestrian movements at Gerji Roba Bakery in both directions and pedestrians do not freely move at pick-up hours. And the respondents confirmed that the availability of disability infrastructure is very poor. Among the people with disabilities in the study area, the number of people with non-functional pathways, difficulty standing and walking, blindness and difficulty seeing are very high.

During both morning and evening peak periods, pedestrian volume count measurements were observed and the three parameters, which include flow rate (VP), pedestrian space (AP) and volume to capacity (V/C) ratios, were considered, calculated and classified as the P-LOS. The results show that the facilities can accommodate pedestrians with PLOS-C and D, but some parts fall to E at both morning and afternoon pick-up hours, and at off-pick hours, all fall to PLOS-A. The results imply that the pedestrian pathway is enough to serve pedestrians, but, based on observation, the sidewalks are not comfortable, accessible, and totally unable to serve disabled people.

6.2. Recommendations

The thesis work on the *challenges facing the pedestrian pathway* from Imperial Hotel to Gerji Roba Bakery suggests that more studies could be conducted to understand the challenges of pedestrian traffic, accidents, and the counter effects as well. The study proposes urban design concepts, street furniture elements, pedestrian needs and volume, traffic movement and capacity as associated countermeasures which are recommended to reduce the level of road traffic problems and their impacts along pedestrian pathways, either through traffic management procedures or by building better infrastructure development which best fits the nation's economic level.

The Addis Ababa Planning commission and Addis Ababa City Administration need to focus on improving their transportation facilities, mainly focusing on pedestrian transportation requirements. Thus, sidewalks in all residential areas from home to their destination, and other public centers could be provided. Provide adequate sidewalks and install street furniture along the sidewalks. It needs to be emphasized that there has been little progress in making pedestrian projects a priority in Addis Ababa City in general.

As the study findings confirm, the conditions and rules of the pedestrian environment in the study area affect all communities. Thus, road safety education and rules and regulations could be provided in schools, work areas, and even through the mass media in the city in the short-term solution. However, in the long term, this could be included in the school curricula, and could be widely addressed at national level.

Local governments, concerned authorities or stakeholders need to prioritize: managing street vendors, through leveling and widening of sidewalks, improving street lighting, removing obstacles and forbidding vehicle parking on footpaths, improving drainage problems, removing dust and unwanted vegetables, adding and making crossing areas more visible, applying vehicle speed reduction and making the pedestrian environment comfortable and accessible.

Frames or advertising signs could not be fixed along footpaths, on poles or structures, and signage could only be displayed during the business's normal hours of operation and must be removed from the trading area at the close of business.

It provides access generally by way of an interconnected network of streets, which facilitates safe, coherent, continuous, efficient, and pleasant walking and could be considered for enhancement by way of a new systematic approach to sidewalks. It could also provide street lighting and pedestrian crossing lights to make the sidewalk areas more visible.

Pedestrian spaces could be designed in consideration of human convenience and have to be qualitatively suitable for the needs of human beings.

Future investigation

In this study raises many factors that affect pedestrian walking movement (accessibility), safety and comfort at Bole Sub-City from Imperial Hotel to Gerji Roba and assessed and analyzed. However, more detailed and further investigation should be conducted regarding pedestrian pathway related issues. Such as:

- ✓ The negative effect of pedestrian pathway safety on disabled communities.
- ✓ An assessment on the behavior of pedestrians, their usage and understanding regarding pedestrian pathway.
- ✓ The comparative and co-relational aspects between pedestrian pathway and carriageway.

Reference

- AACTPMO, A. A. (2017): Addis Ababa Challenges and Opportunities for Non-Motorized Mobility. Addis Ababa, Ethiopia: AACTPMO. Retrieved November 2017, from conrad.richardson@itdp.org
- AASHTO. (2004): Guide for the Planning: Design and Operation of Pedestrian Facilities
- Abrham worku. (2006): Experiences of developed and developing countries in promoting accessibility to the physical environment for PWDs
- Addis Ababa City Administration Road and Transport Bureau; November (2018); Addis Ababa Non- motorized transport strategy 2019-2028
- Americans with Disabilities Act. (1990): Long title: An Act to establish a clear and comprehensive prohibition of discrimination on the basis of disability
- Axelson, P. et al. (1999). Designing Sidewalks and Trails for Access: Federal Highway Administration. Washington DC.
- Buehler R. (2011): Determinants of transport mode choice: a comparison of Germany and the USA. *Journal of Transport Geography*,
- Bisrat K. and Yordanos H. (2016): Streetscapes Design Guideline
- Charles V., Laura S., Margaret Scully. (2008): How to Develop a Pedestrian Safety: Action Plan
- Dinesh Mohan, Omer Tsimhoni, Michael Sivak, Michael J.Flannagan, January (2009): Road Safty In India: challenges and opportunities, the University of Michigan Transportation Research Institute, 2901 Baxter Road Ann Arbor, Michigan 48109-2150 U.S.A
- Dirk Versluis. (2010): Microscopic interaction behavior between individual pedestrians
- Dulac. (2013): Global land transport infrastructure requirements
- ERA, E. R. (2005). Urban Transport study and and preparation of Pilot project in Addis Ababa. Addis Ababa: Saba Engineering.
- Er.Sachin Dass, (2017): Pedestrian Safety on Indian Roads—A Review of Recent Studies International Journal of Engineering Technology Science and Research IJETSR Volume4, Issue9September2017 retrieved from www.ijetsr.com ISSN 2394–3386
- Francesco Pinna and Roberto Murrau. (2017): Isolated and single pedestrians: pedestrian

- groups on sidewalks.
- F.C. Hodgson, M. Page, M.R. Tight (2004): A Review of factors which influence pedestrian use of the streets
- Federal Police Commission of Ethiopia, (2010): Federal police commission citizen charter, retrieved from <http://www.federalpolice.gov.et/documents/10157/d08f09d5-80db-4e8e-aec3-1b6ba5d563f7>
- FRUIN, J J. (1971): City planning: Design: Highway safety: Human characteristics: Pedestrian mall: Pedestrians: Traffic.
- Glele-Ahnhanzo, Y. Kpozehouen, A. Sossa Jerome, c et el., January (2021): My right to walk, my right to live: pedestrian facilities, road and environmental features in Benin, published by BMC Public Health, 21,162(2021), retrieved from <https://doi.org/10.1186/512889-021-10192-2>
- Hawaii Revised Statutes, (2013): MOTOR AND THER VEHICLES 291C, Statewide Traffic Code, 291C-1, Retrieved from [HI Rev Stat § 291C-1 \(2013\)](#)
- Highway Capacity Manual,(2000): Transportation Research Board, Washington, D.C., HCM. (2010): Highway Capacity Manual.
- Hodgson F.C., Page M., Tight M.R. (2004): A review of factors which influence pedestrian use of the streets
- Jane Jacobs and Allan B. Jacobs and recent conversations with folks like Victor Dover: Ben Hamilton-Baillie, and Gil Peñalosa, (2015): A Street you go to, not just through: principles for fostering streets as places.
- John Butcher. (2006): The International Charter for Walking: WALK21 international
- John W. Fischer, April 14, 2010: Specialist in Transportation Policy William J. Mallett Specialist in Transportation Policy
- Juyoung Jung. (2013): The role of street as urban open space for urban regeneration: Dutch neighborhood.
- Leah Preiss. (2006): National Highway: Traffic Safety Administration.
- Levinson, Herberts. March7, (1972): Pedestrian way concepts and case studies, retrieved from <http://worldcat-org/isbn/030919680>
<http://onlinepubs.trb.org/onlinepubs/hrr/1971/355/355-006.pdf>

- Milazzo, J. S., Roupail, N. M., Hummer, J. E., and Allen, D. P. (2000): Quality of Service for Interrupted-Flow Pedestrian Facilities in *Highway Capacity Manual 2000*. In Transportation Research Record 1678, TRB, National Research Council, Washington, D.C., 1999
- Ministry of Transport & Communication, (2010): Project Profile on the Establishment of Traffic Operation Center (TOC) for the City of Addis Ababa. Addis Ababa: (unpublished).
- Natasha Singh,(n.d):Human Ellipse of Indian Pedestrians CSIR- Central Road Research Institute, New Delhi.3Pandit Deendayal Petroleum University, Gandhinagar, Gujarat.natasha30192@gmail.com, punam31@gmail.com, mukti7@gmail.com, rajesh.gujar@sot.pdpu.ac.in
- Paula Santos. (2015): The eight principles of the sidewalk: building more active cities
- Peter Calthorpe, (1993): The Next American Metropolis: Ecology, Community, and the American Dream, published by Princeton Architectural Press, 1993
- RTA. (2011): RTA. Retrieved September 1, 2011, from <http://www.rta.gov.et/accident.htm>
- Sacin Dass, Dr. Praveen Aggarwal, September, (2017): Pedestrian Safety on Indian Roads, A review of recent studies.
- Segni, G. (2013, October). Why are Pedestrian Crashes so Different in Developing Countries?: A Review of Relevant Factors in Relation to their Impact in Ethiopia. Retrieved October 2-4, 2013, from <http://www.patrec.org/atrf.aspx>
- Segni, G. T. (2015). Pedestrian Crashes in Ethiopia: Identification of Contributing Factors through Modelling of Exposure and Road Environment Variables. *A thesis submitted as fulfillment for the Degree of Doctor of Philosophy*.
- Shahin, M. M. Pedestrian Behaviour with Mixed Traffic in Developing Countries. Traffic Engineering and Control, Vol. 47, No. 8, 2006,
- Sharples and Fletcher. (2000): Pedestrian Perceptions of Road Crossing Facilities
- Singh K. and Jain P., 2011, Level of Service of Pedestrian Facilities in an Urban Area (A Critical Evaluation of Factors), Journal of Engineering Technology, Pedestrian Level of Service of Crosswalks in Chandigarh City, Volume 7, Special Issue (Internet of Things)

- Solomon Shanko,(2015): segmental assessment of level of traffic congestion on kality ring road to dukem bridge, A Masters Thesis, published by Addis Ababa University
- The Federal Democratic Republic of Ethiopia, Ministry of Transport, Ethiopian Roads Authority, 13 years Road Sector Development Program (RSDP) Assessment and Launch of Phase IV(RSDP IV), January 2011, and16 years RSDP Assessment, Oct.2013,A.A.
- Tianjiao W. (2012): Study of pedestrian-vehicle interaction behaviour by microscopic simulation modeling. University of Southampton, Faculty of Engineering and the Environment, Doctoral Thesis, published by University of Southampton, Civil Maritime & Env. Eng & Sci Unit
- Transport Research Board, 2000. *Highway Capacity Manual, (HCM2000)*. National Research Council, Washington DC.
- Tulu, G. S., Washington, S., King, M. J. (2013): Pedestrian crashes in Ethiopia
- Rodney Tolley, 29th August, (2003): Sustainable Transport 1st edition, retrieved from www.elsevier.com
- UN-Habitat, (2009) The State of Addis Ababa 2009: The Addis Ababa we want, Published by UN-Habitat
- Washington Metropolitan Area Transit Authority (WMATA), 2005: Issues and Options for Congress
- Web sites (www.trafficdata.info) :ITDb, accessed 22/5/2021, www.cemt.org/JTRC/index.htm Wikipedia – the free encyclopedia)
- WHO, W. H. (2013a): Pedestrian Safety. Assessment, Geneva.
- World Health Organization (2004): World report on road traffic injury prevention: summary, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland (tel: +41 22 791 2476; fax: +41 22 791 4857; e-mail: bookorders@who.int).
- WHO, (2009): Pedestrian safety, A ROAD SAFETY MANUAL FOR DECISION-MAKERSAND PRACTITIONERS World Health Organization20 Avenue Appia1211 G e n e v a 27SwitzerlandE-mail: traffic@who.int retrieved from Web: www.who.int/roadsafety/en/WHO (2013), Pedestrian Safety: a road manual for decision makers and practitioners, publication of world health organization, 20

Avenue Appia, 1211 Geneva27, Switzerland, retrieved from www.who.int.

World highway, March1, (2018) Ethiopian Capital Addis Ababa's road development
retrieved from www.worldhighways.com

Zewude, (2015): *Statistical Analysis of Traffic Injury Severity: The Case Study of Addis Ababa, Ethiopia*. International Journal of Novel Research in Interdisciplinary, Vol. 2, Issue 5.

Appendix A

Questionnaire I: Format for Pedestrians

Confidential Clause

My name is **Bereket Aklilu**. I am currently carrying out thesis research titled “**The challenges facing pedestrian pathway: The case of Imperial Hotel to Gerji (Roba Bakery)**” as a partial fulfillment of MBA in Construction Management at Addis Ababa Science and Technology University, College of Natural & Social Sciences. 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.

I. Demography

- a) Date _____
- b) Site Location _____
- c) Status: Address _____ Age _____ Sex _____
- d) Educational Status _____

II. General Questionnaire

1. How do you perceive walking in Imperial Hotel to Gerji (Roba Bakery) without using a pedestrian pathway?

Very Dangerous ☐ Dangerous ☐ Safe ☐ Very Safe ☐

2. What is the purpose of your journey on this route?

Educational ☐ Recreational ☐ Business/work ☐ Other ☐

3. Which transport mode do you usually want to use?

Walking ☐ Other ☐ (specify). _____

4. Do you know that walking on vehicles Road by leaving pedestrian pathway is illegal by traffic law of Ethiopia?

No ☐ Yes ☐

5. How do you rate the congestion you face on the walkway due to the existence of obstacles on it?
- Very Few ☐ Few ☐ Medium ☐ High ☐ Very High ☐
6. How do you rate the adequacy of the width of the pedestrian pathway from Imperial Hotel to Gerji (Roba Bakery)?
- Very poor ☐ Poor ☐ Satisfactory ☐ Good ☐ Excellent ☐
7. Have you ever seen any traffic accident occurrences while using pedestrian pathway?
- No ☐ Yes ☐
8. If the answer is yes for question 7, what type of Traffic Accident events have you ever observed at the corridor during your journey?
- Sever Fatality ☐ Property Damage ☐ Both of them ☐ Enjury ☐ None of them ☐
9. In your opinion, who will be responsible for the current inconvenient traffic movement system in the pedestrian pathway?
- Pedestrian ☐ Traffic office ☐ Road Aut ☐ All are responsible ☐
10. What do you recommend as a remedial solution for the existing unsafe traffic movement system from Imperial Hotel to Gerji (Roba bekery)?
- _____
- _____
- _____
11. How do you rate the adequacy of road amenities or availability of pedestrian facilities like sidewalks, pavements quality (maintenance)?
- Very poor ☐ Poor ☐ Satisfactory ☐ Good ☐ Excellent ☐
12. Do you think that the pedestrian pathway is comfortable or have enough infrastructures for disability persons?
- No ☐ Yes ☐
13. How do you rate the negative effect of illegal temporary and permanent road side vendor stress on a pedestrian?
- ☐ ☐ ☐ ☐

No Effect
Effect

Slight Effect

High Effect

Very

High

14. Have you ever seen pedestrian pathway uses for other function (for parking or car wash) and affect pedestrian movement?

No ☐ Yes ☐

15. How could you explain the drainage problem and walk way network on the specified road?

Low ☐ Medium ☐ High ☐ Very High ☐

III. Dependent Questionnaire

16. Do you think that the pedestrian and pathway are safety from Imperial Hotel to Gerji Roba Street?

No ☐ Yes ☐

Questionnaire II:

Rating of List of Factors affecting Pedestrian Safety by Pedestrians

The general objective of the questionnaire is to investigate pedestrian safety problems in Addis Ababa. Factors influencing pedestrian safety are listed and you are expected to rate the importance from your experience as a pedestrian in Addis Abeba (No 1-11). The option of evaluation is based upon Likert scale ranging from **VeryBad**(1st level) to **Very Good** (5th level).

INSTRUCTIONS

✚ The variables were rated on the Five Point Likert Scales which have importance rating values from 1 to 5. Please, give your details by ticking one of the boxes provided.

For rating 1 very bad, for rating 2 bad, for rating 3 satisfactory, for rating 4 good and for rating 5 very good

✚ Ticking in more than one box on the same row of variable is not allowed.

✚ You can use any symbol you want for ticking (X...).

Factors affecting Pedestrian Safety format

Survey area name: Bole Sub-city, Imperial Hotel to Gerji (Roab Bakery)

Area Type: Residential and Commercial

Table: Factors Influencing Pedestrian Safety

	Factors	Importance rating				
		5	4	3	2	1
1	Obstructions(excavation, Rubbish)					
	• wrong set tree, pole on pedestrian walkway					
	• dust bin on pedestrian walkway					
2	Pedestrian Accident					
	• Exposure of pedestrians to other modes					
	• Conflict (crash) between pedestrian					
3	Pedestrian Behavior					
	•Pedestrian Careless, Reckless or in a Hurry					
	•Pedestrian entered Carriageway without due care					
4	Motorist Behavior					
	• Behavior of driver toward pedestrian					
	• Behavior of driver toward road conditions					

Appendix B

Observation on the challenges facing pedestrian pathway

(In the case of Imperial Hotel to Gerji (Roba) street)

Researcher observation data collection format

Obstruction characteristics and elements of pedestrians

No	The characteristics of obstruction		quantity	No. of problems that be seen	Reasons that the problems appear	Remark
1	Street light pole					
2	Advertising sign	Overhead hanging				
		Not over head hanging				
3	Plant/Tree					
4	Bollard					
5	Shop awning					
6	Drainage					
7	Under construction					
8	Shoe shine bench					
9	Garbage through box					
10	Ramp					
12	Crossing surface					

Appendix C

Pedestrian Count Data and Pedestrian Flow

Date: One

Day of the week: Tuesday

Pedestrian Location (Local Reference Land Mark): Gerji (Roba Bakery)

Time Intervals	Number of pedestrians		WE of EF	WE of EF * 15	Vp = $\frac{V15}{15 * WE \text{ of EF}}$	WE OF FE	WE of FE*15	Vp = $\frac{V15}{15 * WE \text{ of FE}}$
	Direction							
	EF	FE						
8:00-8:15AM	914	927	1.39	20.85	43.83693046	1.27	19.05	48.66142
8:15-8:30AM	910	911	1.39	20.85	43.64508393	1.27	19.05	47.82152
8:30-8:45AM	912	913	1.39	20.85	43.74100719	1.27	19.05	47.92651
8:45-9:00AM	874	887	1.39	20.85	41.91846523	1.27	19.05	46.56168
9:00-9:15AM	786	794	1.39	20.85	37.69784173	1.27	19.05	41.67979
9:15-9:30AM	692	700	1.39	20.85	33.18944844	1.27	19.05	36.74541
9:30-9:45AM	579	621	1.39	20.85	27.76978417	1.27	19.05	32.59843
9:45-10:00AM	487	530	1.39	20.85	23.35731415	1.27	19.05	27.82152
10:00-10:15AM	408	458	1.39	20.85	19.56834532	1.27	19.05	24.04199
10:15-10:30AM	341	382	1.39	20.85	16.35491607	1.27	19.05	20.05249
10:30-10:45AM	297	303	1.39	20.85	14.24460432	1.27	19.05	15.90551
10:45-11:00AM	216	223	1.39	20.85	10.35971223	1.27	19.05	11.70604

11:00-11:15AM	186	147
11:15-11:30AM	133	128
11:30-11:45AM	127	112
11:45AM - 12:00PM	129	119
2:00-2:15PM	97	96
2:15-2:30PM	96	90
2:30-2:45PM	94	92
2:45-3:00PM	99	97
3:00-3:15PM	112	107
3:15-3:30PM	146	139
3:30-3:45PM	190	182
3:45-4:00PM	243	231
4:00-4:15PM	263	278
4:15-4:30PM	300	313
4:30-4:45PM	341	354
4:45-4:00PM	387	394
5:00-4:15PM	435	449
5:15-5:30PM	501	512
5:30-5:45PM	562	570
5:45-6:00PM	617	626
Total	12474	12685
Average		

1.39	20.85	8.920863309	1.27	19.05	7.716535
1.39	20.85	6.378896882	1.27	19.05	6.71916
1.39	20.85	6.091127098	1.27	19.05	5.879265
1.39	20.85	6.18705036	1.27	19.05	6.246719
1.39	20.85	4.652278177	1.27	19.05	5.03937
1.39	20.85	4.604316547	1.27	19.05	4.724409
1.39	20.85	4.508393285	1.27	19.05	4.829396
1.39	20.85	4.748201439	1.27	19.05	5.091864
1.39	20.85	5.371702638	1.27	19.05	5.616798
1.39	20.85	7.002398082	1.27	19.05	7.296588
1.39	20.85	9.112709832	1.27	19.05	9.553806
1.39	20.85	11.65467626	1.27	19.05	12.12598
1.39	20.85	12.61390887	1.27	19.05	14.59318
1.39	20.85	14.38848921	1.27	19.05	16.43045
1.39	20.85	16.35491607	1.27	19.05	18.58268
1.39	20.85	18.56115108	1.27	19.05	20.68241
1.39	20.85	20.86330935	1.27	19.05	23.56955
1.39	20.85	24.02877698	1.27	19.05	26.87664
1.39	20.85	26.95443645	1.27	19.05	29.92126
1.39	20.85	29.59232614	1.27	19.05	32.86089
1.39	20.85	598.2733813	1.27	19.05	665.8793

Pedestrian Count Data and Pedestrian Flow

Date: Two

Day of the week: Wednesday

Pedestrian Location (Local Reference Land Mark): Gerji (Roba Bakery)

Time Intervals	Number of pedestrians		WE of EF	WE of EF * 15	Vp = $\frac{V15}{15 * WE \text{ of EF}}$	WE of FE	WE of FE*15	Vp = $\frac{V15}{15 * WE \text{ of FE}}$
	Direction							
	EF	FE						
8:00-8:15AM	905	874	1.39	20.85	43.40528	1.27	19.05	45.87927
8:15-8:30AM	911	876	1.39	20.85	43.69305	1.27	19.05	45.98425
8:30-8:45AM	913	868	1.39	20.85	43.78897	1.27	19.05	45.5643
8:45-9:00AM	889	741	1.39	20.85	42.63789	1.27	19.05	38.89764
9:00-9:15AM	784	634	1.39	20.85	37.60192	1.27	19.05	33.28084
9:15-9:30AM	694	527	1.39	20.85	33.28537	1.27	19.05	27.66404
9:30-9:45AM	583	493	1.39	20.85	27.96163	1.27	19.05	25.87927
9:45-10:00AM	499	421	1.39	20.85	23.93285	1.27	19.05	22.09974
10:00-10:15AM	412	387	1.39	20.85	19.76019	1.27	19.05	20.31496
10:15-10:30AM	336	312	1.39	20.85	16.11511	1.27	19.05	16.37795
10:30-10:45AM	276	239	1.39	20.85	13.23741	1.27	19.05	12.54593
10:45-11:00AM	204	174	1.39	20.85	9.784173	1.27	19.05	9.133858
11:00-11:15AM	171	122	1.39	20.85	8.201439	1.27	19.05	6.404199
11:15-11:30AM	121	103	1.39	20.85	5.803357	1.27	19.05	5.406824
11:30-11:45AM	100	94	1.39	20.85	4.796163	1.27	19.05	4.934383

11:45AM - 12:00PM	156	117
2:00-2:15PM	94	82
2:15-2:30PM	86	84
2:30-2:45PM	89	89
2:45-3:00PM	99	89
3:00-3:15PM	127	86
3:15-3:30PM	136	94
3:30-3:45PM	189	117
3:45-4:00PM	204	170
4:00-4:15PM	293	219
4:15-4:30PM	298	282
4:30-4:45PM	337	294
4:45-4:00PM	395	337
5:00-4:15PM	432	395
5:15-5:30PM	496	453
5:30-5:45PM	552	562
5:45-6:00PM	611	641
Total	12392	10976
Average		

1.39	20.85	7.482014	1.27	19.05	6.141732
1.39	20.85	4.508393	1.27	19.05	4.304462
1.39	20.85	4.1247	1.27	19.05	4.409449
1.39	20.85	4.268585	1.27	19.05	4.671916
1.39	20.85	4.748201	1.27	19.05	4.671916
1.39	20.85	6.091127	1.27	19.05	4.514436
1.39	20.85	6.522782	1.27	19.05	4.934383
1.39	20.85	9.064748	1.27	19.05	6.141732
1.39	20.85	9.784173	1.27	19.05	8.923885
1.39	20.85	14.05276	1.27	19.05	11.49606
1.39	20.85	14.29257	1.27	19.05	14.80315
1.39	20.85	16.16307	1.27	19.05	15.43307
1.39	20.85	18.94484	1.27	19.05	17.69029
1.39	20.85	20.71942	1.27	19.05	20.73491
1.39	20.85	23.78897	1.27	19.05	23.77953
1.39	20.85	26.47482	1.27	19.05	29.50131
1.39	20.85	29.30456	1.27	19.05	33.64829
1.39	20.85	594.3405	1.27	19.05	576.168

Pedestrian Count Data and Pedestrian Flow

Date: Three

Day of the week: Thursday

Pedestrian Location (Local Reference Land Mark): Gerji (Roba

Time Intervals	Number of pedestrians		WE of EF	WE of EF * 15	$V_p = \frac{V_{15}}{15 * WE\ of\ EF}$	WE of FE	WE of FE*15	$V_p = \frac{V_{15}}{15 * WE\ of\ FE}$
	Direction							
	EF	FE						
8:00-8:15AM	897	886	1.39	20.85	43.02158	1.27	19.05	46.50919
8:15-8:30AM	906	889	1.39	20.85	43.45324	1.27	19.05	46.66667
8:30-8:45AM	910	860	1.39	20.85	43.64508	1.27	19.05	45.14436
8:45-9:00AM	874	794	1.39	20.85	41.91847	1.27	19.05	41.67979
9:00-9:15AM	711	721	1.39	20.85	34.10072	1.27	19.05	37.84777
9:15-9:30AM	654	644	1.39	20.85	31.36691	1.27	19.05	33.80577
9:30-9:45AM	587	600	1.39	20.85	28.15348	1.27	19.05	31.49606
9:45-10:00AM	520	559	1.39	20.85	24.94005	1.27	19.05	29.34383
10:00-10:15AM	446	409	1.39	20.85	21.39089	1.27	19.05	21.46982
10:15-10:30AM	382	422	1.39	20.85	18.32134	1.27	19.05	22.15223
10:30-10:45AM	309	372	1.39	20.85	14.82014	1.27	19.05	19.52756
10:45-11:00AM	261	303	1.39	20.85	12.51799	1.27	19.05	15.90551
11:00-11:15AM	197	261	1.39	20.85	9.448441	1.27	19.05	13.70079
11:15-11:30AM	132	212	1.39	20.85	6.330935	1.27	19.05	11.12861
11:30-11:45AM	110	147	1.39	20.85	5.275779	1.27	19.05	7.716535

11:45AM - 12:00PM	122	131
2:00-2:15PM	90	91
2:15-2:30PM	90	82
2:30-2:45PM	86	87
2:45-3:00PM	87	84
3:00-3:15PM	95	85
3:15-3:30PM	130	96
3:30-3:45PM	189	112
3:45-4:00PM	221	188
4:00-4:15PM	290	237
4:15-4:30PM	341	291
4:30-4:45PM	384	350
4:45-4:00PM	401	389
5:00-4:15PM	442	417
5:15-5:30PM	489	472
5:30-5:45PM	539	505
5:45-6:00PM	597	567
Total	12489	12263
Average		

1.39	20.85	5.851319	1.27	19.05	6.87664
1.39	20.85	4.316547	1.27	19.05	4.776903
1.39	20.85	4.316547	1.27	19.05	4.304462
1.39	20.85	4.1247	1.27	19.05	4.566929
1.39	20.85	4.172662	1.27	19.05	4.409449
1.39	20.85	4.556355	1.27	19.05	4.461942
1.39	20.85	6.235012	1.27	19.05	5.03937
1.39	20.85	9.064748	1.27	19.05	5.879265
1.39	20.85	10.59952	1.27	19.05	9.868766
1.39	20.85	13.90887	1.27	19.05	12.44094
1.39	20.85	16.35492	1.27	19.05	15.27559
1.39	20.85	18.41727	1.27	19.05	18.3727
1.39	20.85	19.23261	1.27	19.05	20.41995
1.39	20.85	21.19904	1.27	19.05	21.88976
1.39	20.85	23.45324	1.27	19.05	24.7769
1.39	20.85	25.85132	1.27	19.05	26.50919
1.39	20.85	28.63309	1.27	19.05	29.76378
1.39	20.85	598.9928	1.27	19.05	643.727

Pedestrian Count Data and Pedestrian Flow

Date: One

Day of the week: Tuesday

Pedestrian Location (Local Reference Land Mark): Taxi Tera

Time Intervals	Number of pedestrians									
	Direction									
	CD	DC	WE of CD	WE of CD * 15	$V_p = \frac{V15}{15 * WE \text{ of CD}}$	WE of DC	WE of DC * 15	$V_p = \frac{V15}{15 * WE \text{ of DC}}$		
8:00-8:15AM	824	714	1.15	17.25	47.76811594	1.2	18	39.66667		
8:15-8:30AM	816	716	1.15	17.25	47.30434783	1.2	18	39.77778		
8:30-8:45AM	839	729	1.15	17.25	48.63768116	1.2	18	40.5		
8:45-9:00AM	786	654	1.15	17.25	45.56521739	1.2	18	36.33333		
9:00-9:15AM	649	582	1.15	17.25	37.62318841	1.2	18	32.33333		
9:15-9:30AM	570	511	1.15	17.25	33.04347826	1.2	18	28.38889		
9:30-9:45AM	489	453	1.15	17.25	28.34782609	1.2	18	25.16667		
9:45-10:00AM	412	398	1.15	17.25	23.88405797	1.2	18	22.11111		
10:00-10:15AM	341	338	1.15	17.25	19.76811594	1.2	18	18.77778		
10:15-10:30AM	274	264	1.15	17.25	15.88405797	1.2	18	14.66667		
10:30-10:45AM	222	211	1.15	17.25	12.86956522	1.2	18	11.72222		
10:45-11:00AM	180	174	1.15	17.25	10.43478261	1.2	18	9.66667		
11:00-11:15AM	136	140	1.15	17.25	7.884057971	1.2	18	7.77778		
11:15-11:30AM	107	123	1.15	17.25	6.202898551	1.2	18	6.83333		
11:30-11:45AM	102	100	1.15	17.25	5.913043478	1.2	18	5.55556		

11:45AM - 12:00PM	121	117
2:00-2:15PM	86	79
2:15-2:30PM	80	74
2:30-2:45PM	89	83
2:45-3:00PM	91	80
3:00-3:15PM	107	96
3:15-3:30PM	112	112
3:30-3:45PM	129	151
3:45-4:00PM	168	177
4:00-4:15PM	211	195
4:15-4:30PM	253	223
4:30-4:45PM	290	246
4:45-4:00PM	327	294
5:00-4:15PM	349	331
5:15-5:30PM	376	356
5:30-5:45PM	469	374
5:45-6:00PM	531	423
Total	10536	9518
Average		

1.15	17.25	7.014492754	1.2	18	6.5
1.15	17.25	4.985507246	1.2	18	4.388889
1.15	17.25	4.637681159	1.2	18	4.111111
1.15	17.25	5.15942029	1.2	18	4.611111
1.15	17.25	5.275362319	1.2	18	4.444444
1.15	17.25	6.202898551	1.2	18	5.333333
1.15	17.25	6.492753623	1.2	18	6.222222
1.15	17.25	7.47826087	1.2	18	8.388889
1.15	17.25	9.739130435	1.2	18	9.833333
1.15	17.25	12.23188406	1.2	18	10.83333
1.15	17.25	14.66666667	1.2	18	12.38889
1.15	17.25	16.8115942	1.2	18	13.66667
1.15	17.25	18.95652174	1.2	18	16.33333
1.15	17.25	20.23188406	1.2	18	18.38889
1.15	17.25	21.79710145	1.2	18	19.77778
1.15	17.25	27.1884058	1.2	18	20.77778
1.15	17.25	30.7826087	1.2	18	23.5
1.15	17.25	610.7826087	1.2	18	528.7778

Pedestrian Count Data and Pedestrian Flow

Date: Two

Day of the week: Wednesday

Pedestrian Location (Local Reference Land Mark): Taxi Tera

Time Intervals	Number of pedestrians		WE of CD	WE of CD * 15	$V_p = \frac{V15}{15 * WE\ of\ CD}$	WE of DC	WE of DC * 15	$V_p = \frac{V15}{15 * WE\ of\ DC}$
	Direction							
	CD	DC						
8:00-8:15AM	831	709	1.15	17.25	48.17391	1.2	18	39.38889
8:15-8:30AM	820	710	1.15	17.25	47.53623	1.2	18	39.44444
8:30-8:45AM	832	708	1.15	17.25	48.23188	1.2	18	39.33333
8:45-9:00AM	774	643	1.15	17.25	44.86957	1.2	18	35.72222
9:00-9:15AM	654	596	1.15	17.25	37.91304	1.2	18	33.11111
9:15-9:30AM	582	534	1.15	17.25	33.73913	1.2	18	29.66667
9:30-9:45AM	499	463	1.15	17.25	28.92754	1.2	18	25.72222
9:45-10:00AM	422	410	1.15	17.25	24.46377	1.2	18	22.77778
10:00-10:15AM	339	328	1.15	17.25	19.65217	1.2	18	18.22222
10:15-10:30AM	265	273	1.15	17.25	15.36232	1.2	18	15.16667
10:30-10:45AM	212	218	1.15	17.25	12.28986	1.2	18	12.11111
10:45-11:00AM	173	182	1.15	17.25	10.02899	1.2	18	10.11111
11:00-11:15AM	145	136	1.15	17.25	8.405797	1.2	18	7.555556
11:15-11:30AM	103	121	1.15	17.25	5.971014	1.2	18	6.722222
11:30-11:45AM	98	102	1.15	17.25	5.681159	1.2	18	5.666667

11:45AM - 12:00PM	130	113
2:00-2:15PM	82	74
2:15-2:30PM	80	79
2:30-2:45PM	91	81
2:45-3:00PM	94	79
3:00-3:15PM	103	92
3:15-3:30PM	109	103
3:30-3:45PM	122	138
3:45-4:00PM	178	157
4:00-4:15PM	201	190
4:15-4:30PM	246	216
4:30-4:45PM	287	238
4:45-4:00PM	311	286
5:00-4:15PM	331	301
5:15-5:30PM	382	329
5:30-5:45PM	476	367
5:45-6:00PM	537	403
Total	10509	9379
Average		

1.15	17.25	7.536232	1.2	18	6.277778
1.15	17.25	4.753623	1.2	18	4.111111
1.15	17.25	4.637681	1.2	18	4.388889
1.15	17.25	5.275362	1.2	18	4.5
1.15	17.25	5.449275	1.2	18	4.388889
1.15	17.25	5.971014	1.2	18	5.111111
1.15	17.25	6.318841	1.2	18	5.722222
1.15	17.25	7.072464	1.2	18	7.666667
1.15	17.25	10.31884	1.2	18	8.722222
1.15	17.25	11.65217	1.2	18	10.55556
1.15	17.25	14.26087	1.2	18	12
1.15	17.25	16.63768	1.2	18	13.22222
1.15	17.25	18.02899	1.2	18	15.88889
1.15	17.25	19.18841	1.2	18	16.72222
1.15	17.25	22.14493	1.2	18	18.27778
1.15	17.25	27.5942	1.2	18	20.38889
1.15	17.25	31.13043	1.2	18	22.38889
1.15	17.25	609.2174	1.2	18	521.0556

Pedestrian Count Data and Pedestrian Flow

Date: Three

Day of the week: Thursday

Pedestrian Location (Local Reference Land Mark): Taxi Tera

Time Intervals	Number of pedestrians		WE of CD	WE of CD * 15	WE of DC		WE of DC * 15	V15	
	Direction				Vp = $\frac{V15}{15 * WE\ of\ CD}$	Vp = $\frac{V15}{15 * WE\ of\ DC}$			
	CD	DC							
8:00-8:15AM	822	715	1.15	17.25	47.65217	1.2	18	39.72222	
8:15-8:30AM	819	715	1.15	17.25	47.47826	1.2	18	39.72222	
8:30-8:45AM	820	721	1.15	17.25	47.53623	1.2	18	40.05556	
8:45-9:00AM	782	696	1.15	17.25	45.33333	1.2	18	38.66667	
9:00-9:15AM	700	622	1.15	17.25	40.57971	1.2	18	34.55556	
9:15-9:30AM	621	567	1.15	17.25	36	1.2	18	31.5	
9:30-9:45AM	543	501	1.15	17.25	31.47826	1.2	18	27.83333	
9:45-10:00AM	480	444	1.15	17.25	27.82609	1.2	18	24.66667	
10:00-10:15AM	411	398	1.15	17.25	23.82609	1.2	18	22.11111	
10:15-10:30AM	363	317	1.15	17.25	21.04348	1.2	18	17.61111	
10:30-10:45AM	297	254	1.15	17.25	17.21739	1.2	18	14.11111	
10:45-11:00AM	211	202	1.15	17.25	12.23188	1.2	18	11.22222	
11:00-11:15AM	160	146	1.15	17.25	9.275362	1.2	18	8.111111	
11:15-11:30AM	122	110	1.15	17.25	7.072464	1.2	18	6.111111	
11:30-11:45AM	97	91	1.15	17.25	5.623188	1.2	18	5.055556	

11:45AM - 12:00PM	104	98
2:00-2:15PM	86	82
2:15-2:30PM	84	76
2:30-2:45PM	86	79
2:45-3:00PM	91	81
3:00-3:15PM	99	95
3:15-3:30PM	107	100
3:30-3:45PM	137	140
3:45-4:00PM	189	167
4:00-4:15PM	203	194
4:15-4:30PM	246	221
4:30-4:45PM	292	248
4:45-4:00PM	307	287
5:00-4:15PM	360	322
5:15-5:30PM	413	349
5:30-5:45PM	417	381
5:45-6:00PM	486	413
Total	10955	9832
Average		

1.15	17.25	6.028986	1.2	18	5.444444
1.15	17.25	4.985507	1.2	18	4.555556
1.15	17.25	4.869565	1.2	18	4.222222
1.15	17.25	4.985507	1.2	18	4.388889
1.15	17.25	5.275362	1.2	18	4.5
1.15	17.25	5.73913	1.2	18	5.277778
1.15	17.25	6.202899	1.2	18	5.555556
1.15	17.25	7.942029	1.2	18	7.777778
1.15	17.25	10.95652	1.2	18	9.277778
1.15	17.25	11.76812	1.2	18	10.77778
1.15	17.25	14.26087	1.2	18	12.27778
1.15	17.25	16.92754	1.2	18	13.77778
1.15	17.25	17.7971	1.2	18	15.94444
1.15	17.25	20.86957	1.2	18	17.88889
1.15	17.25	23.94203	1.2	18	19.38889
1.15	17.25	24.17391	1.2	18	21.16667
1.15	17.25	28.17391	1.2	18	22.94444
1.15	17.25	635.0725	1.2	18	546.2222

Pedestrian Count Data and Pedestrian Flow

Date: One

Day of the week: Tuesday

Pedestrian Location (Local Reference Land Mark): Imperial Hotel

Time Intervals	Number of pedestrians								
	Direction								
	AB	BA							
			WE of AB	WE of AB * 15	$V_p = \frac{V15}{15 * WE \text{ of AB}}$	WE of BA	WE of BA * 15	$V_p = \frac{V15}{15 * WE \text{ of BA}}$	
8:00-8:15AM	548	536	1.26	18.9	28.99470899	1.13	16.95	31.62242	
8:15-8:30AM	546	530	1.26	18.9	28.88888889	1.13	16.95	31.26844	
8:30-8:45AM	540	527	1.26	18.9	28.57142857	1.13	16.95	31.09145	
8:45-9:00AM	534	515	1.26	18.9	28.25396825	1.13	16.95	30.38348	
9:00-9:15AM	517	502	1.26	18.9	27.35449735	1.13	16.95	29.61652	
9:15-9:30AM	486	435	1.26	18.9	25.71428571	1.13	16.95	25.66372	
9:30-9:45AM	436	405	1.26	18.9	23.06878307	1.13	16.95	23.89381	
9:45-10:00AM	392	326	1.26	18.9	20.74074074	1.13	16.95	19.23304	
10:00-10:15AM	324	296	1.26	18.9	17.14285714	1.13	16.95	17.46313	
10:15-10:30AM	261	225	1.26	18.9	13.80952381	1.13	16.95	13.27434	
10:30-10:45AM	202	174	1.26	18.9	10.68783069	1.13	16.95	10.26549	
10:45-11:00AM	174	115	1.26	18.9	9.206349206	1.13	16.95	6.784661	
11:00-11:15AM	112	102	1.26	18.9	5.925925926	1.13	16.95	6.017699	
11:15-11:30AM	100	97	1.26	18.9	5.291005291	1.13	16.95	5.722714	

11:30-11:45AM	103	94	1.26	18.9	5.44973545	1.13	16.95	5.545723
11:45AM - 12:00PM	113	99	1.26	18.9	5.978835979	1.13	16.95	5.840708
2:00-2:15PM	75	64	1.26	18.9	3.968253968	1.13	16.95	3.775811
2:15-2:30PM	86	69	1.26	18.9	4.55026455	1.13	16.95	4.070796
2:30-2:45PM	84	78	1.26	18.9	4.444444444	1.13	16.95	4.60177
2:45-3:00PM	96	82	1.26	18.9	5.079365079	1.13	16.95	4.837758
3:00-3:15PM	98	83	1.26	18.9	5.185185185	1.13	16.95	4.896755
3:15-3:30PM	127	96	1.26	18.9	6.71957672	1.13	16.95	5.663717
3:30-3:45PM	133	121	1.26	18.9	7.037037037	1.13	16.95	7.138643
3:45-4:00PM	184	127	1.26	18.9	9.735449735	1.13	16.95	7.492625
4:00-4:15PM	198	148	1.26	18.9	10.47619048	1.13	16.95	8.731563
4:15-4:30PM	205	174	1.26	18.9	10.84656085	1.13	16.95	10.26549
4:30-4:45PM	221	189	1.26	18.9	11.69312169	1.13	16.95	11.15044
4:45-4:00PM	238	194	1.26	18.9	12.59259259	1.13	16.95	11.44543
5:00-4:15PM	294	216	1.26	18.9	15.55555556	1.13	16.95	12.74336
5:15-5:30PM	331	227	1.26	18.9	17.51322751	1.13	16.95	13.39233
5:30-5:45PM	373	248	1.26	18.9	19.73544974	1.13	16.95	14.63127
5:45-6:00PM	382	281	1.26	18.9	20.21164021	1.13	16.95	16.57817
Total	8513	7375	1.26	18.9	450.4232804	1.13	16.95	435.1032
Average								

Pedestrian Count Data and Pedestrian Flow

Date: Two

Day of the week: Wednesday

Pedestrian Location (Local Reference Land Mark): Imperial Hotel

Time Intervals	Number of pedestrians							
	Direction							
	AB	BA						
			WE of AB	WE of AB * 15	$V_p = \frac{V_{15}}{15 * WE \text{ of AB}}$	WE of BA	WE of BA * 15	$V_p = \frac{V_{15}}{15 * WE \text{ of BA}}$
8:00-8:15AM	551	544	1.26	18.9	29.15344	1.13	16.95	32.0944
8:15-8:30AM	557	553	1.26	18.9	29.4709	1.13	16.95	32.62537
8:30-8:45AM	553	550	1.26	18.9	29.25926	1.13	16.95	32.44838
8:45-9:00AM	536	522	1.26	18.9	28.35979	1.13	16.95	30.79646
9:00-9:15AM	497	489	1.26	18.9	26.2963	1.13	16.95	28.84956
9:15-9:30AM	448	437	1.26	18.9	23.7037	1.13	16.95	25.78171
9:30-9:45AM	389	400	1.26	18.9	20.58201	1.13	16.95	23.59882
9:45-10:00AM	351	363	1.26	18.9	18.57143	1.13	16.95	21.41593
10:00-10:15AM	310	322	1.26	18.9	16.40212	1.13	16.95	18.99705
10:15-10:30AM	286	295	1.26	18.9	15.13228	1.13	16.95	17.40413
10:30-10:45AM	262	257	1.26	18.9	13.86243	1.13	16.95	15.16224
10:45-11:00AM	227	234	1.26	18.9	12.01058	1.13	16.95	13.80531
11:00-11:15AM	198	184	1.26	18.9	10.47619	1.13	16.95	10.85546
11:15-11:30AM	152	149	1.26	18.9	8.042328	1.13	16.95	8.79056

11:30-11:45AM	112	124
11:45AM - 12:00PM	128	130
2:00-2:15PM	96	91
2:15-2:30PM	94	95
2:30-2:45PM	86	90
2:45-3:00PM	97	89
3:00-3:15PM	102	98
3:15-3:30PM	100	107
3:30-3:45PM	117	127
3:45-4:00PM	135	139
4:00-4:15PM	186	169
4:15-4:30PM	217	194
4:30-4:45PM	266	253
4:45-4:00PM	283	284
5:00-4:15PM	291	303
5:15-5:30PM	354	341
5:30-5:45PM	402	399
5:45-6:00PM	451	436
Total	8834	8768
Average		

1.26	18.9	5.925926	1.13	16.95	7.315634
1.26	18.9	6.772487	1.13	16.95	7.669617
1.26	18.9	5.079365	1.13	16.95	5.368732
1.26	18.9	4.973545	1.13	16.95	5.60472
1.26	18.9	4.550265	1.13	16.95	5.309735
1.26	18.9	5.132275	1.13	16.95	5.250737
1.26	18.9	5.396825	1.13	16.95	5.781711
1.26	18.9	5.291005	1.13	16.95	6.312684
1.26	18.9	6.190476	1.13	16.95	7.492625
1.26	18.9	7.142857	1.13	16.95	8.20059
1.26	18.9	9.84127	1.13	16.95	9.970501
1.26	18.9	11.48148	1.13	16.95	11.44543
1.26	18.9	14.07407	1.13	16.95	14.92625
1.26	18.9	14.97354	1.13	16.95	16.75516
1.26	18.9	15.39683	1.13	16.95	17.87611
1.26	18.9	18.73016	1.13	16.95	20.11799
1.26	18.9	21.26984	1.13	16.95	23.53982
1.26	18.9	23.86243	1.13	16.95	25.72271
1.26	18.9	467.4074	1.13	16.95	517.2861

Pedestrian Count Data and Pedestrian Flow

Date:

Day of the week:

Pedestrian Location (Local Reference Land Mark):

Time Intervals	Number of pedestrians		WE of AB	WE of AB * 15	Vp = $\frac{V15}{15 * WE \text{ of AB}}$	WE of BA	WE of BA * 15	Vp = $\frac{V15}{15 * WE \text{ of BA}}$
	Direction							
	AB	BA						
8:00-8:15AM	553	539	1.26	18.9	29.25926	1.13	16.95	31.79941
8:15-8:30AM	556	543	1.26	18.9	29.41799	1.13	16.95	32.0354
8:30-8:45AM	555	540	1.26	18.9	29.36508	1.13	16.95	31.85841
8:45-9:00AM	524	520	1.26	18.9	27.72487	1.13	16.95	30.67847
9:00-9:15AM	490	497	1.26	18.9	25.92593	1.13	16.95	29.32153
9:15-9:30AM	452	461	1.26	18.9	23.91534	1.13	16.95	27.19764
9:30-9:45AM	401	413	1.26	18.9	21.21693	1.13	16.95	24.36578
9:45-10:00AM	360	376	1.26	18.9	19.04762	1.13	16.95	22.18289
10:00-10:15AM	321	333	1.26	18.9	16.98413	1.13	16.95	19.64602
10:15-10:30AM	274	302	1.26	18.9	14.49735	1.13	16.95	17.81711
10:30-10:45AM	255	268	1.26	18.9	13.49206	1.13	16.95	15.81121
10:45-11:00AM	235	227	1.26	18.9	12.43386	1.13	16.95	13.39233
11:00-11:15AM	196	201	1.26	18.9	10.37037	1.13	16.95	11.85841
11:15-11:30AM	157	163	1.26	18.9	8.306878	1.13	16.95	9.616519

11:30-11:45AM	129	134
11:45AM - 12:00PM	125	121
2:00-2:15PM	81	84
2:15-2:30PM	84	72
2:30-2:45PM	80	86
2:45-3:00PM	91	89
3:00-3:15PM	87	93
3:15-3:30PM	98	100
3:30-3:45PM	112	123
3:45-4:00PM	127	136
4:00-4:15PM	169	180
4:15-4:30PM	207	210
4:30-4:45PM	246	239
4:45-4:00PM	289	285
5:00-4:15PM	299	301
5:15-5:30PM	348	343
5:30-5:45PM	391	387
5:45-6:00PM	436	420
Total	8728	8786
Average		

1.26	18.9	6.825397	1.13	16.95	7.905605
1.26	18.9	6.613757	1.13	16.95	7.138643
1.26	18.9	4.285714	1.13	16.95	4.955752
1.26	18.9	4.444444	1.13	16.95	4.247788
1.26	18.9	4.232804	1.13	16.95	5.073746
1.26	18.9	4.814815	1.13	16.95	5.250737
1.26	18.9	4.603175	1.13	16.95	5.486726
1.26	18.9	5.185185	1.13	16.95	5.899705
1.26	18.9	5.925926	1.13	16.95	7.256637
1.26	18.9	6.719577	1.13	16.95	8.023599
1.26	18.9	8.941799	1.13	16.95	10.61947
1.26	18.9	10.95238	1.13	16.95	12.38938
1.26	18.9	13.01587	1.13	16.95	14.10029
1.26	18.9	15.29101	1.13	16.95	16.81416
1.26	18.9	15.82011	1.13	16.95	17.75811
1.26	18.9	18.4127	1.13	16.95	20.23599
1.26	18.9	20.68783	1.13	16.95	22.83186
1.26	18.9	23.06878	1.13	16.95	24.77876
1.26	18.9	461.7989	1.13	16.95	518.3481