ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Identifying Integrated Factors Influencing Pedestrian Level of Satisfaction on Existing Pedestrian Facility (In Case of Addis Ababa: - Mexico, Megenagna and Aratkillo Walkway)

BY

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A Thesis
Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Road and Transport Engineering

June, 2023
Addis Ababa, Ethiopia

CERTIFICATE

The undersigned below have examined the thesis entitled ‘’ Identifying Integrated Factors Influencing Pedestrian Level of Satisfaction on Existing Pedestrian Facility (In Case of Addis Ababa: - Mexico, Megenagna and Aratkillo Walkway) presented by Amanuel Zemene, a candidate for the degree of Master of Science and hereby certify that it is worthy of acceptance.

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Abstract

Walking is the best sustainable mode of transport because it is not only cheap but also zeros emission transport system. Walking mode of transport do not require special skills, because they are deemed convenient for all groups, where people manage the intensity of their movements themselves. Despite the advantage of walking mode of transport, there is no standard pedestrian facility not only in quality but also the capacity Therefore, the main objective of this study is performance evaluation of pedestrian level of service and assessing the existing pedestrian walking facility level of service in terms of pedestrian satisfaction level.

In order to achieve the objective of this study ordinal logistic regressions have been employed by following factor analysis of multiple external factors in addition to HCM2000 method. A total of 390 pedestrian attitudinal surveys and pedestrian video graphic survey had been taken for the analysis. The method of analysis was logistic regression analysis by following principal component analysis of multiple external factors and HCM 2000 method for performance evaluation of level of service. Based on the result of factor analysis (principal component analysis), four major grouped factors have been extracted such as walking facility problem, traffic safety problem, comfort and convenience issue, and security problem that have been able to explain the total variance of 32.6%,21.3%,13.5% and 8.4% respectively. As per the result of ordinal logistic regression external factors such as walking facility problem, as comfort and convenience, and traffic safety problems are found to affect pedestrians' level of satisfaction on existing pedestrian facility. From socio-demographic characteristics of pedestrian Education level, Age category, Health condition, and purpose of tripe and income level of pedestrian are the most significant variable which influence the satisfaction level of pedestrian in addition to external factor. The level of service of selected existing pedestrian facility are also found very lowest which are PLOS E, D and F based on different parameters.

Keyword: Walking, Pedestrian, Level of satisfaction, Ordinal logistic regression, Factor analysis and PLOS

ACKNOWLEDGMENT

Praise and Glory be to Almighty God, for helping me throughout my life, giving me strength, courage, determination and the capability to accomplish this research.

This thesis appears in its current form due to the assistance and guidance of several people. I would like to offer my sincere thanks to all of them including those, not listed here under.

I am deeply indebted to my advisor, Dr. Getu Segne, for his wilful advising, intellectual encouragement, valuable guidance and moral support for the success of my research.

I would like to thank Ethiopian Roads Authority for crafting education. I would also like to give my sincere thanks to Addis Ababa University for allowing me to pursue my studies.

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1. INTRODUCTION

Walking is the best sustainable mode of transport because it is not only cheap but also zeros emission transport system. Walking mode of transport do not require special skills, because they are deemed convenient for all groups, where people manage the intensity of their movements themselves. Despite the advantage of walking mode of transport, there is no standard pedestrian facility not only in quality but also the capacity that can accommodate the peak hour demand of pedestrian in Addis Ababa city, and the provided facility is also not barriered from vehicular road by keeping the surface as it is but, 60 % (AATMA, 2019)Addis Ababa resident are using walking as mode of transport. Despite the advantage of transportation which is the backbone of economy and development of urban areas, but, the cost of facility and environmental impact of transport are the main problem of most country, yet. To create smart city and sustainable environment, several researches and policies are implemented in European countries and china on public and non-motorized transport which is environmentally friend and economical in terms of land and operation cost (Adkins, A.,, Dill, J., , Luhr, G., & Neal, M. , 2012), (Asadi-Shekari, Moeinaddini, & Zaly, 2013), (Holland, & Hill, 2007), (Kim, E. J., , Kim, J., , & Kim, H. , 2020) and (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014).

In a developing country like Ethiopia, social and economic status has an important role in the socio-demographic of the society and in everyday behavior especially in transportation mode of selection. On the other hand, segregation of status is noted, including in provision of facilities, such as urban transportation facilities. This includes facilities related to promoting active transportation, like walking pathways, streetscapes, and landscapes, even when the majority of higher-income earners are able to own and drive their own private vehicles. This is unlike lower-income earners, many of whom suffer from the need to for good transportation to travel to work, but are rarely enabled to do this with proper facilities to promote active transportation (Papageorgiou, G., , Balamou, E., , Efstathiadou, T., , Xergia, S., , & Maimaris, A. , 2018). This shown the public transportation service particularly pedestrian walking and cycle path, which also relates to issues of connectivity, accessibility, and mobility in the residential areas for lower-income earners (González, S. A., , Aubert, S., , Barnes, J. D., , Larouche, R., , & Tremblay, M. S. , 2020). On the absence of social-demographic and economic status, both developments provide facilities are provided to all levels of the society. Thus, the purpose of this research is also to

evaluate the performance of pedestrian level of service and identify whether pedestrians are satisfied on selected pedestrian section regardless of discrimination of facilities in any types of group category or not. Therefore, this paper tries to evaluate the performance pedestrian level of service and identifying factors affecting pedestrian level of satisfaction on selected area of Addis Ababa such as Mexico, Megenagna and Arat Killo walkway.

Walking is the most available non-motorized modes of transport in developing countries including Ethiopia from short trip to long trip. Walking is not only important for maintaining better health condition but also the best mechanism of reducing traffic congestion with zero-emission (E. M. Cepolina, F. Menichini, & P. Gonzalez , 2018) and (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014). Despite all those advantages of walking mode of transport, but almost all the budgets are invested for motorized infrastructure which are very expensive with low efficiency and capacity as per walking facility.

Even though, walking is the best mode of transport to maintain good health, reducing traffic congestion and zero emission system, the frequency and severity of the accident is high. According to the *Global status report on road safety 2018*, launched by world health organization (WHO, 2018) pedestrians are being the most vulnerable road users in Africa. Most citizens of developing country used walking because it is mostly available with no-cost. In Addis-Ababa, 55% trip makers used walking as a daily mode of transport (AATMA, 2019). However, lack of available walking space and unprotected available walking space are the main problem and determinant of Addis-Ababa walking environment. Due to this reason, pedestrians are the most affected road users with more than 86% of fatalities (AATMA, 2019). By recognizing the advantage of walking as a mode of transport, Addis-Ababa city are currently constructing and upgrading pedestrian facility in different sub city but not consider the perception and attitude of pedestrians as per their socio-economic characteristics and external factor. Pedestrian walking satisfaction level are related to socio-economic characteristics, demographic characteristics, health condition of pedestrian and external road related factor.

The main objective of this study is performance evaluation of pedestrian level of service and identifying factors affecting pedestrian level of satisfaction on existing facility in Addis-Ababa down town areas. The major factors will be identified using principal factor analysis and logistic regressions have been employed to identify the effect of socio-economic and demographic

characteristics on pedestrian level of satisfaction. Level of service of existing pedestrian facility are determined by using highway capacity manual (HCM-2000).

1.1 Statement of the problem

In Addis-Ababa, the number of populations is increasing time to time which is difficult to meet the demand of transport. Addis Ababa city road Authority (AACRA) is currently constructed several road networks in the city but, the congestion is increasing yet, and the capacity and efficiency of the road is low since there are a number of passenger cars have occupied most relative space than walking space. Walking is the most available cheap mode of transport in both rural and urban areas of Ethiopia. In Addis-Ababa which is the capital city of Ethiopia, the amount and network of motorized vehicle roads much greater than the pedestrian network, but, 55 percentage of Addis-Ababa resident are used walking as a mode of transport (AATMA, 2019). However, the provided and existing pedestrian facilities are low as compared to the number of trip maker who used walking as a main mode of transport.

Addis Ababa existing pedestrian facilities are also unprotected, unsafe and not constructed in well-standard quality. Due to this reason, pedestrians are the most vulnerable road user for accident in Addis-Ababa city. Recently due to the reason of having pedestrian's facility unprotected, the vehicle is gone out of the roadway, then fatality and injury occurred on the pedestrian around wolo sefer roundabout. Pedestrians are the most affected road users with more than 86% of fatalities happened to them (AATMA, 2019). From that accident, more fatal accidents are concentrated on major road in which major roads pass through high pedestrian activities. According to the report of Addis-Ababa traffic management agency using the measure of the International Road Assessment Program (iRAP) star rating system on different road user, Addis-Ababa urban road (using 114km road network) is three times safer for vehicles occupant than pedestrians (AATMA, 2019). This way more than 86% of pedestrians are affected by fatal crash.

Addis-Ababa city are currently constructing and upgrading existing pedestrian facility in down town areas. However, the constructed pedestrian facility is not research based of pedestrian behavior and perception towards their level of satisfaction. The behavior and perception are affected by socio-economic characteristics, demographic characteristics and health condition of pedestrians. The perception of pedestrian can be from security, safety, obstruction of objects, lighting condition and width of walk way issue. This study will investigate factors affecting

pedestrian walking behavior and identifies the most important factors contribute to walking perception

1.2 Objective of the study

1.2.1 General objective

Performance evaluation of pedestrian facility level of service, and Identifying factors affecting level of satisfaction of pedestrian on down town areas of Addis Ababa.

1.2.2 Specific objective

I. Identify external factors affecting pedestrian walking satisfaction on existing pedestrian facility in down town areas of Addis Ababa.
II. Evaluating the influence of socio-economic, demographic characteristics and external factors on pedestrian level of satisfaction
III. Performance evaluation of pedestrian facility level of service.

1.3 Hypothesis and Research Question

1.3.1 Hypothesis

When this study is completed, it is expected to obtain knowledge about the current performance of pedestrian level of service, about factors that affect pedestrian walking satisfaction and factors that influence of level of satisfaction on existing pedestrian facility of Addis Ababa downtown area that have high volume of pedestrian intensity and fatal accident. Then after, the new design and constructing pedestrian facility should consider those influential factors of most pedestrian perception and behaviors.

1.3.2 Research Question

I. What are the external factors influencing satisfaction of pedestrian on existing pedestrian facility in down town areas of Addis Ababa?
II. What are the effects of socio-demographic and other external factors of pedestrian on their level of satisfaction?
III. What are the level of service of existing pedestrian facility (PLOS) on the aspects of capacity?

1.4 Significance of the study

The output of this study is used for urban transport planner, designer and transport management agency to consider most factors that have most probability of maximizing pedestrian facility level of service and pedestrian satisfaction and to discount factors that have negative effect on pedestrian walking satisfaction and facility level of service. For the future, non-motorized transport will be intentional and viable type of mode of transport in all means such as in low cost, zero-emission and environmentally friend. To create safe, sustainable and smart city, pedestrian walking facility is the number one to be provided as urban infrastructure which consider all of the above influential factors.

1.5 Scope of the study

This study is conducted on Addis Ababa; three down town areas that have high intensity of pedestrian and pedestrian related traffic accident sites such **as Megenagna, Mexico** and **Aratkilo** walk ways. The data are collected using well-structured questioners and in deep interviews for randomly selected pedestrians. Study area is selected based on the criteria of having many Governmental and private office area; commercial area and school area are located that means pedestrian density and volume are very high throughout the day especially during morning and evening time of the day based on preliminary observational survey.

1.6. Limitation of the study

The data is collected through both well-structured questioners and deep interviews, the data may have hesitated in terms of representativeness of the whole population. The number of study site is very small as compared to the available walking site due to limitation of resource and time which is difficult to generalize as per Addis Ababa pedestrian's facility.

1.7. Organization of the Paper

This study was organized in five chapters. Chapter one gives a brief overview of the general background of the study, statement of the problem, the general and specific objectives of the study, research question, and scope of the study. Chapter two deals with a review of relevant literature. Chapter three describes research methodology including a description of the study area, data collection, extraction and analysis of methodology, sample size determination and study design. Detailed data analysis and discussion of results is presented in chapter four. Conclusion and recommendations are drawn in the last chapter.

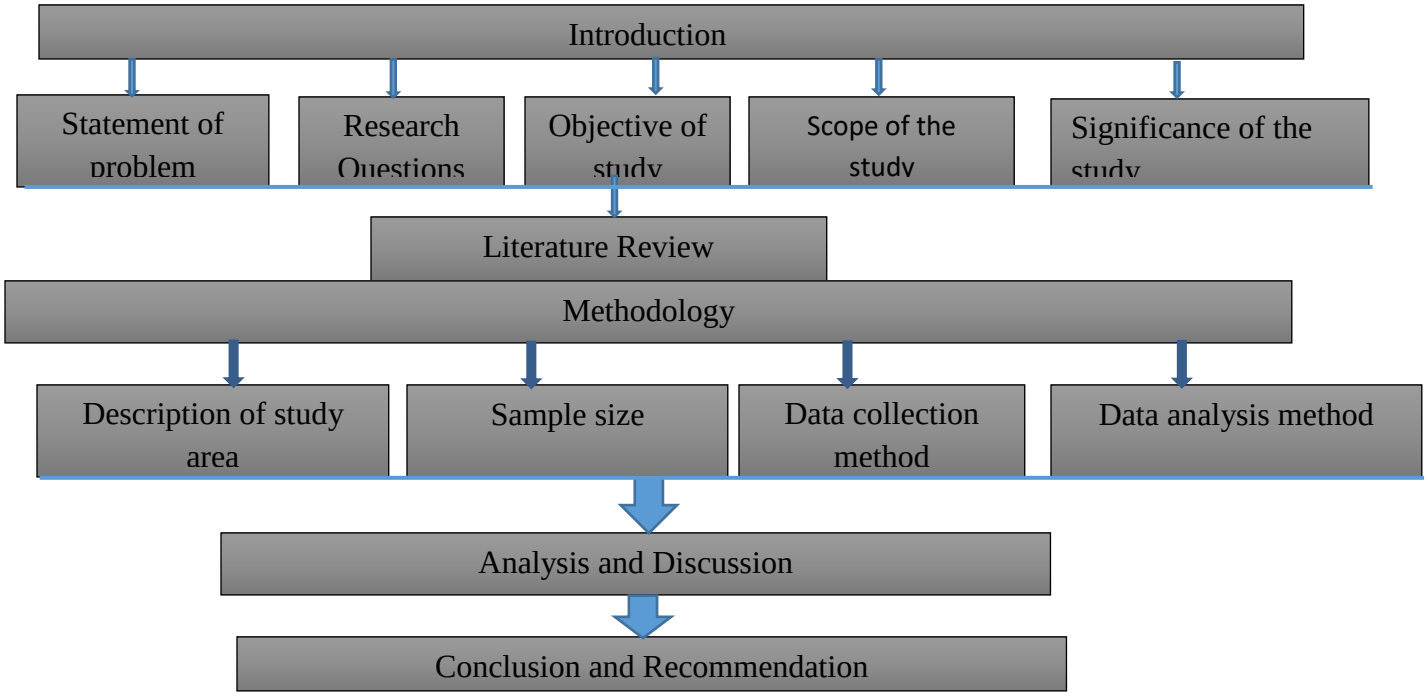

Figure 1: Structural organization of the paper

2. LITERATURE REVIEW

2.1. Introduction

Cities are become the best place to live, attracting more and more people and activities. The population living in the city have been continually on a sharp rise, with 70% of the world's population predicted to be living in cities by 2050 (United Nations, 2018)making cities critical to achieving a sustainable future for the world. However, this movement represents a threat to the environment, with challenges and opportunities of cities especially in transportation system. Walking is one part of green transport system used treat the challenges of traffic congestion, economy and environmental impact.

3.2 Non-Motorized Transportation

Active transportation or non-motorized transportation refers to human-powered transportation mainly walking and cycling (Kim, E. J., , Kim, J., , & Kim, H. , 2020).

Different studies on sustainable transportation consider active transportation as an integral physical activity (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014). Built environment factors, consisting of the surroundings that provide the setting for physical activity, can influence behavior toward walking and cycling (Williams, G. C., , Borghese, M. M., , & Janssen, I. , 2017). As walking and cycling do not require special skills, they are deemed convenient for all age groups, where people manage the intensity of their movements themselves (Kim, E. J., , Kim, J., , & Kim, H. , 2020).

Walkability is created by connecting built environment elements, such as commercial areas, housing, transportation, recreational parks, and green spaces. Active transportation has been defined as a multifaceted concept that includes several built environment elements (Adkins, A.,, Dill, J., , Luhr, G., & Neal, M. , 2012). Walkability is usually linked to the quality of the built environment and connected by the quality of the pedestrian environment. The condition of the sidewalk plays an important role in increasing the level of walkability of the built environment. The sidewalk path context and quality of sidewalk network are adequate predictors to walkability that has the ability to affect the walking likelihood and increased walkability in a city (S. & J. , 2011). Lack of walkable elements within the sidewalk can negatively affect pedestrian walking behavior. Safe walking environment will also be influenced pedestrian activities positively (J. &

N., 170).The tendency of people to walk more often and farther increased in an environment with high sidewalk qualities (S. & J. , 2011) and (Ji & Gu, 2011).

Commuters walk and cycle because of the aesthetic aspects of the surrounding environment. An area perceived as demonstrating good aesthetics persuades pedestrians to use active transportation (Adkins, A.,, Dill, J., , Luhr, G., & Neal, M. , 2012) and (L. Kang, Y. Xiong, & F. L. Mannering, 2013). This can be achieved through a range of activities that includes constructing pedestrian facilities and infrastructures within a pedestrian-oriented development. Typically, built environment quality influences the walkability of a city; therefore, the elements of a built environment should be designed aesthetically based on planning standards and guidelines to provide a pleasant travel experience for active transportation users (Asadi-Shekari, Moeinaddini, & Zaly, 2013) Indeed, planning a walkable city involves the effective use of skill and knowledge by relevant authorities in the field of built environment.

Generally, two fundamental concepts of urban form affect travel choice: land use density and connectivity between complementary activities, such as working, shopping, and playing. In sustainable transportation, connectivity is associated with how the modes of transport are linked, especially in public transportation. Most users are willing to use active transportation for shorter distances (Young, D. R., et al., 2020).

Although shorter distances promote walking or cycling, users are nevertheless inclined to avoid using active transportation for safety reasons. Most people tend to walk and cycle if they feel safe in their surroundings (Asadi-Shekari, Moeinaddini, & Zaly, 2013), (Williams, G. C., , Borghese, M. M., , & Janssen, I. , 2017) and (Papageorgiou, G., , Balamou, E., , Efstathiadou, T., , Xergia, S., , & Maimaris, A. , 2018). Therefore, built environment features that lead to traffic hazards should be eliminated to create walkability. Comfort level also contributes to the pleasantness of active transportation ((Papageorgiou, G., , Balamou, E., , Efstathiadou, T., , Xergia, S., , & Maimaris, A. , 2018).Furthermore, connectivity and distance are associated with each other, with both being important for creating a walkable city (Papageorgiou, G., , Balamou, E., , Efstathiadou, T., , Xergia, S., , & Maimaris, A. , 2018). Therefore, the built environment can enhance active transportation infrastructure.

To create smart city, encouraging green transport system such as non-motorized transport is one specific objective of United Nations (United Nation, 2015). However, in developing world such as Ethiopia, achieving 2030 sustainable development agenda is impossible because huge number of capitals is invested for the passenger car facility rather than pedestrian facility.

As was already noted, the walkability concept was included into the design of the majority of his toric cities. In ancient towns and cities that were constructed with a low number of motor cars in mind, it is essential to have a walkability-friendly environment (Khisty, 1994).

Any new alterations to the existing building structures and surrounds are forbidden due to conservation and preservation laws (Khisty, 1994). These ancient towns and cities might not be able to continue with an increase in automobiles from residents and visitors each year. Therefore, it is believed that encouraging walkability is the best strategy for addressing tourists' transportation difficulties in these historic sites. But walkability can only occur if there are designated pedestrian paths.

Studies have revealed that walking is influenced by physical characteristics (Sahani & Bhuyan, 2020). These characteristics include the caliber of the route, zebra crossings, street decor, safety precautions, and nearby traffic flow. To enjoy the architectural heritage's urban beauty, visitors might wish to stroll more. Promoting the historical path will not only help it develop, but will also make it more fascinating and unforgettable (Khisty, 1994).

2.3. Perception and walking behavior of pedestrians

There are many studies conducted to know the pedestrian walking perception, on existing facility of pedestrian and level of satisfaction of pedestrian. Based on the result of several study, pedestrians are influenced by various factors like pedestrian perception, roadway, pedestrian age, pedestrian gender and environmental characteristics. Pedestrian level of service (PLOS) might be compared to any performance evaluation instrument, with the tool's effectiveness determined by how well it can capture every part of the process.

A service quality measure, for instance, takes into account two ideas groups perception and expectations in the business or marketing industries (Ford, Macallum, & Tait, 1986).If a connection were to be formed between such metrics and pedestrian level of service(PLOS), perception would refer to users' experiences with the facility, while expectation would cover all of the built-in and operational features.

Walking is the most cheap and available mode of transport which used by pedestrian from short to long trip. However, walking activity is suffering from pedestrian facilities, comfort, convenience, connectivity with different modes of transport and roadway environmental characteristics (Shay & Iacono, 2010).

The following basic criteria for pedestrian level of service assessment used which consist of six categories, the type of pedestrian facility provided, the conflict between pedestrians and motor vehicles, and the existence of supporting facilities (amenities) to accommodate the movement of pedestrians, vehicular level of service (VLOS), maintenance and support for multimodal transport. The quality of pedestrian facilities in urban transportation systems can have an impact on more than just the likelihood of pedestrians walking; the number of facilities offered is insufficient given the volume and demand for pedestrians (Xi & Son, 2010).

Despite the fact that walking is important for the environment as well as for economy, the Addis Ababa metropolitan transit network only provides minimal pedestrian facilities in the majority of locations, including megenagna, Mexico, and Arat-Kilo. Because, inadequate pedestrian facilities can be the main cause of traffic crash between the pedestrians and the vehicles on the roadway, between pedestrian and another pedestrian, parked vehicles and with roadside object (Laxman, Rastogi, & Chandra , 2010). Unfortunately, the government of Ethiopian never have been conducting any type of study about the traffic mode of walking which can not only increase the traffic congestion of urban road network, but also increase the fatality of pedestrian since using unsafe, unsecured and crowded facility. Now days, more pedestrian facility are constructed in different country to promote sustainable transport goal.

Pedestrian tend to walk more frequently if higher quality walkways are provided to them in all accessible way (Marisamynathan & Lakshmi, 2016). Enhancement projects such as the provision of safer road crossings, sidewalk widening, removal of high kerb obstacles, tree planting for landscape improvement and other enhancement projects have been initiated to promote and facilitate pedestrian walkable city.

A walkable city promotes sustainable development in transportation through its benefits that includes environment preservation, reduction in traffic congestion, increased economic activity, increased health and social benefits (Shay & Iacono, 2010).

Dandan. et al. (Dandan, Wei, Jian, & Yang, 2007) Suggests that apart from the physical environment characteristics, walkability should also take into consideration of pedestrians' perception and emotion.

The decision to use a walking facility by an individual is significantly influenced by perception. According to research, elements of consumer perception like lack of comfort, convenience, and the physical built-up aspects of the walking environment, such as the existence of driveways, bus stops, and the number of vehicle lanes are found to be lower pedestrian satisfaction, which in turn influences their decision to walk (Bivina, Parida, Advani, & Parida, 2018). (Ford, Macallum, & Tait, 1986) had examined correlations between the volume of pedestrian traffic and various physical the impact of the built environment on flow at the street and neighborhood levels characteristics.

If the pedestrian decides to walk, then they walk the road somewhere and so the pedestrian behavior changes dynamically. Pedestrians endlessly amendment their actions with relation to environmental characteristics. The availability of larger gaps in traffic stream is incredibly rare, that the behavior of pedestrian varies with availability of little gaps and that they try and settle smaller gaps with tactical behavior. Gap is outlined because the time distinction between front vehicle and lag vehicle and its crucial term in pedestrian road crossing behavior. During this process, the vital gap (the minimum average gap length that's accepted by 1/2 of all pedestrians to cross the road safely) plays a serious role. Pedestrian gap acceptance behavior is affected by many factors and it is also important issue when we see from safety point of view. On this line, few studies have mentioned pedestrian road crossing behavior with help of gap acceptance criteria. Some studies have also explained the pedestrian gap acceptance behavior with behavioral and statistical analysis.

Several studies in different country give also significant facts concerning pedestrian socio-demographic characteristics (such as age, gender) and the way these characteristics influence pedestrian walking behavior and perception. Such studies have centered on elaborate experiments to seek out the impact of age on walking perception and behavior along the side of the road (Lobjois & Cavallo, 2007). Most of those studies are applied during a virtual environment. Pedestrian walking behavior with relation to gender has also been observed in various studies. Males have a tendency to indicate more hazardous road walking behavior than females because of

less waiting time (Khan & Tiwari, 2007). However, this type of study is not conducted before in our country but the number of pedestrian greater than other mode commuter. A related study (Bernhoft & Carstensen, 2008) discovered that older pedestrians appreciate sidewalks and crossing facilities much more than younger pedestrians. Older pedestrians in most country are recommended by health experts due to health issue and they are not aware about new technology based mode of transport. (Rosenbloom, 2008) Have used an analogous technique to look at the crossing behavior of kids and located that not looking was the foremost prevailing unsafe behavior, followed by the mixture of not looking and not stopping, and not stopping before crossing. They additionally found that children accompanied by an adult committed additional unsafe behaviors, particularly once not holding hands with the adult. In Addis-Ababa, all type of inter zonal trips are made by walking along with the road of vehicle. That is why, 86% of Addis Ababa drivers are exposed for fatality.

2.4. Socio-Economic Factors related to Non-motorized Transportation

In a developing country like Ethiopia, social and economic status has an important role in the sociodemographic of society and in everyday behavior. Segregation of status is noted, including in provision of facilities, such as urban transportation facilities. This includes facilities related to promoting active transportation, like walking pathways, streetscapes, and landscapes, even when the majority of higher-income earners are able to own and drive their own private vehicles. This is unlike lower-income earners, many of whom suffer from the need to for good transportation to travel to work, but are rarely enabled to do this with proper facilities to promote active transportation.

This shown the public transportation service particularly pedestrian walking path, which also relates to issues of connectivity, accessibility, and mobility in the residential areas for lower-income earners. For instance, the urban transportation facility found in Bangsar and Shah Alam, are best example, where urban planning is paramount and the neighborhoods overall are provided with good pathways, streetscapes, and landscapes. Both developments were sensibly planned for “car-oriented” development as well as being provided with good walking facilities, such as pathways, small parks, and playgrounds, and connections between commercial areas and residential areas within walking distance.

On the absence of social-demographic and economic status, both developments provide facilities are provided to all levels of society. Thus, the purpose of this research is also to understand whether active transportation is achieved in a neutral area where there is no discrimination of facilities in any types of residential development or public area. Therefore, this paper tries to evaluate if there are differences between sociodemographic status implications and differences in active transportation in a neutral setting of on selected area of Addis Ababa such as Aratkillo, Megenagna and Mexico.

Several researchers have revealed that sociodemographic characteristics affect non-motorized transportation use such as walking and cycle. Sociodemographic factors such as gender, age, household income level, and education level have been associated with user behavior toward active transportation usage (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014) , (Kim, E. J., , Kim, J., , & Kim, H. , 2020), (Williams, G. C., , Borghese, M. M., , & Janssen, I. , 2017), (González, S. A., , Aubert, S., , Barnes, J. D., , Larouche, R., , & Tremblay, M. S. , 2020)

Users from different races or ethnic groups may have specific opinions on walking and cycling. Age is an attribute of travel behavior, where it has been suggested that older people use active transportation less frequently than younger people (Marquet, O., , Hipp, J. A., , & Miralles-Guasch, C. , 2017), (Papageorgiou, G., , Balamou, E., , Efstathiadou, T., , Xergia, S., , & Maimaris, A. , 2018) and (Rišová, K., & Madajová, M. S. , 2020).

Contrary to this (Lyu, Y., & Forsyth, A. , 2021) reported that older people are more likely to walk. Middle-aged and older adults tend to be reflective during long-distance walks (Mau, M.,, Nielsen, D. S., , Jakobsen, I. S., , Klausen, S. H., , & Roessler, K. K, 2021) describing walking as a strenuous, simple, solitary, and calming activity.

Gender significantly affected pedestrian behavior toward walkability (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014), (Marquet, O., , Hipp, J. A., , & Miralles-Guasch, C. , 2017). (Papageorgiou, G., , Balamou, E., , Efstathiadou, T., , Xergia, S., , & Maimaris, A. , 2018) and (Kim, E. J., , Kim, J., , & Kim, H. , 2020).

Nevertheless, (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014) mentioned that many studies have reported inconsistent results between genders. (Asadi-Shekari, Moeinaddini, & Zaly, 2013) supported those findings, stating that both men and women profess quite similar opinions on pedestrian walkways. Even so, some researchers believe that gender plays a significant role in determining the choice of transportation mode. (Rišová, K., & Madajová, M. S. , 2020) reported significant gender differences in safety perception toward walking. Women tend to feel unsafe when walking, while men are less concerned about feeling safe. Due to the issue of safety, women choose to drive rather than walk for travel purposes (Seong, E. Y., , Lee, N. H., , & Choi, C. G, 2021).

The findings on the association of income and active transportation use are varied. According to (Jamal, S., & Mohiuddin, H. , 2020)and (Seong, E. Y., , Lee, N. H., , & Choi, C. G, 2021), the low-income group comprises the primary walkers and cyclists, whereas the high-income group prefer driving for daily trips. This is due to a higher household income being associated with higher car ownership, discouraging walking (Jamal, S., & Mohiuddin, H. , 2020). Nonetheless, (Young, D. R., et al., 2020) noted that low-income households demonstrate a low frequency of active transportation opportunities. Furthermore, (Hilland, T. A., , et al., 2020)reported no significant association between income and active transportation use. There is some association between employment status and active transportation usage. Employed people engage in a high level of walking as they are expected to walk consistently during their occupational activities (Hilland, T. A., , et al., 2020) and (Rišová, K., & Madajová, M. S. , 2020). In contrast, (Lyu, Y. & Forsyth, A. , 2021)) reported that non-working people are more likely to walk during daily travel

2.5 Attitudes and level of Satisfaction of pedestrian

Essentially, researchers have developed three approaches to assessing pedestrian level of service. The first method takes into account pedestrian traffic and sidewalk geometry. The second type is based on the road environment's quality. The final method considers both traffic flow operations and road physical characteristic. The assessing parameters for pedestrian level of service are pedestrian flow operation, sidewalk geometry, space occupancy, and sidewalk capacity. As a result, these methods continue to ignore pedestrians.

(Dandan, Wei, Jian, & Yang, 2007) created a method for calculating pedestrian LOS based on pedestrian perceptions. The respondents were divided into three groups based on their age, gender, and walking ability. After that, a questionnaire survey was carried out. We used a stepwise regression model to make a model. The model included a number of variables, including bicycle volume and pedestrian volume, vehicle volume, driveway access per meter, and sidewalk distance to car lanes,

Rahaman et al. (2005) attempted to investigate the qualitative level of pedestrian comfort in Dhaka by providing six broad categories of roadside walking environments in terms of safety, security, and convenience convenience and comfort, walkway continuity, system coherence, and attractiveness by some specialized services. Some qualitative data had been gathered through an observation survey whereas the responses of the walker were recorded using a questionnaire survey.

In modern world, the quality of life and well-beingness has been increased from time to time, the paradigm of the transportation sector has been changing from a car-oriented transportation system to an eco-friendly, pedestrian- or people-oriented urban space by keeping the availability of walking facility as it is.

Walking is the most basic means of transportation for humans and is the basis of all activities such as commuting, going to school, work, and leisure. In terms of transportation, walking itself is also a form of travel, and it serves as a link between various transportation modes such as buses and subways. In addition, many studies claim that walking provides various functions other than transportation modes. For instance, Oh and Seo (Oh & Seo, 2015)] have found that the concept of walking in urban design has expanded continuously with the times from the primary means of transportation.

At microscopic level, the perspective of understanding walking has been expanded as a means of experience and recognition of urban space, a means of leisure, performing social functions, and a monitoring function of public (Oh & Seo, 2015). (Oh & Seo, 2015) emphasizes the Eco - friendliness of walking because it relies on human power and has little impact on the environment. It contributes to revitalizing the economy of a city or community, promotes social exchange and local economic activities, and connects different transport activity.

Sarkar (2003) presented some theoretical guidelines for qualitatively assessing the levels of comfort provided along walkways in major activity centers. The method was created by combining environmental psychology, landscape architecture, and urban planning. The method included two separate evaluations: service level, which provides standards for overall desirable and undesirable comfort conditions at the macro level, and comfort level, which provides standards for overall desirable and undesirable comfort conditions at the micro level. The quality level examines the finer details of pedestrian comfort at the micro level. Physical, physiological, and psychological comfort were used to determine the service level and quality level. The requirements for comfort varied depending on cultural and geological factors.

Based on the pedestrian-oriented policy paradigm shift, research to evaluate and analyze pedestrian satisfaction has actively been conducting. According to Ji and Gu (Ji & Gu, 2011) the factors of the walking environment that affect pedestrian satisfaction are identified as safety, security, scenery, comfort, and convenience.

A case study investigating the pedestrian satisfaction of traditional markets in Korea classified the influential factors into safety, comfort, convenience, and interest (Chung, 2012).Besides safety, convenience, and comfort, other studies suggested street environments for instance, air quality, noise, natural shade ,planting, or street continuity and visibility as evaluation or design elements (Chung, 2012).

Based on the common walkability metrics and attributes from the literature and consideration of the built environment of urban design of the country. This study categorizes factors affecting pedestrian satisfaction into safety, convenience, security and comfort to examine differences in satisfaction by land use and street type.

Safety is the presence of sidewalks associated with illegal parking, perceived safety level from traffic accidents, illegally placed objects and vehicle travel speed. (Chung, 2012), (Khisty, 1994), (Sahani & Bhuyan, 2020).

Convenience is another requirement of pedestrian facility which implies sufficiency of pedestrian guidance facilities, sidewalk material (pavement condition), sidewalk slope, easiness to access public transportation facilities, (Chung, 2012), (Campisi, Ignaccolo, Inturri, & Tesoriere, 2021), (Oh & Seo, 2015)

Comfort: is the critical requirement of pedestrian facility that must bring for pedestrian, in terms of pedestrian volume, the sufficiency of green space, cleanliness, noise level, (Chung, 2012), (

Campisi, Ignaccolo, Inturri, & Tesoriere, 2021), (Oh & Seo, 2015), (Sahani & Bhuyan, 2020) and (Blecˇic, Cecchini, Congiu , Fancello, & Talu, 2020)

Using trip quality as a basis, Jaskiewicz (2000) suggested a method for evaluating pedestrian level of service. Measurements of the pleasantness, safety, and functionality of nine different pedestrian system evaluations were made. The nine metrics are: enclosure/definition, complexity of path networks, building articulations, intricate space design, transparency, buffers, shading, trees, overhangs/awnings/various roof lines, and physical elements/conditions. These precautions were each developed based on a combination of safety concerns, volume and capacity considerations, and qualitative design elements. The study's findings showed that pedestrian level of service along with more conventional variables like volume and capacity, appraisal should take into account some qualitative aspects of the road environment. In addition to volume and capacity considerations, it is crucial to pay more attention to pedestrian comfort and safety in order to make walking a more appealing means of transportation.

Inside the SARTRE-4 European survey on road users' attitudes, perceptions and behavior, a dedicated questionnaire was addressed to pedestrians from nineteen countries. The statistical analysis that followed (Papadimitriou, 2013) discovered seven elements of pedestrian attitudes and behavior (formed on the basis of fifty four form elements), namely: satisfaction with pedestrian environment, attitudes towards penalties, attitudes towards electronic in-vehicle devices, attitudes towards speed limitations and surveillance, pedestrian behavior and distraction, attitudes towards pedestrian safety design, annoyance with alternative road users and lack of accessibility. Moreover, pedestrians were clustered in 3 groups: positive attitudes and positive behavior, negative attitudes and negative behavior, and mixed attitudes and positive behavior, with vital variation over gender, age groups and countries. Although, the study has not considered all type of socio-demographic characteristics and physical distraction elements of pedestrian walkway are not included that may not be the objective.

(Granié, 2013) developed and tested a form for the self-reporting behavior of pedestrians. Out of forty-seven components tested, twenty were found to be most vital for assessing pedestrian behavior, inside four elements, namely: "transgression", "lapses", "aggressive behavior" and "positive behavior "conditions or facility design factors.

The physical condition of the elements as walking environments and how pleased individuals are with their walking experiences when using them are two factors that contribute to pedestrian

happiness, according to Sahani and Bhuyan's study (Sahani & Bhuyan, 2020). Using such physical criteria or facility design factors, multiple studies have assessed the walkability of various cities throughout the world (S. Marisamynathan & S. Lakshmi, Method to determine pedestrian level of service for sidewalks in Indian context, , 2018), (Bernhoft & Carstensen, 2008), (Asadi-Shekari, Moeinaddini, & Zaly, 2013) and (Campisi, Ignaccolo, Inturri, & Tesoriere, 2021).

Walkability, according to Blecic.et.al. (Blecˇic, Cecchini, Congiu , Fancello, & Talu, 2020), assesses how well-suited an urban setting is to incorporate pedestrian walkways or features that by nature make walking practical, secure, pleasant, and desirable.

The examination of the urban peripheralization process by Blecic and Cecchini (Blecˇic, Cecchini, Congiu , Fancello, & Talu, 2020) which is characterized by geographical and socioeconomic inequality, demonstrates the necessity of include walkability as a vital component. Walking enhances urban accessibility and travel equity because it is socially equitable, or available to most people without hindrance.

According to Distefano.et.al. ((Campisi, Ignaccolo, Inturri, & Tesoriere, 2021)), elderly or handicapped persons prioritize certain elements of walking environments according to their physical capabilities. The authors suggest a new walkability measure based on thermal comfort ((Campisi, Ignaccolo, Inturri, & Tesoriere, 2021)). Having a quick journey time, a barrier-free environment that can be navigated on foot, safety, pedestrian infrastructure, and upmarket and pleasant strolling settings are some other definitions offered by Forsyth and South worth for walkability.

The presence and continuity of sidewalks, accessibility of facilities to people with different abilities, directness of pedestrian paths, connections to frequent transit services, ease and safety of crossings, visual interest, and perceived or actual walkability are just a few of the aspects of walkability that share commonalities across the literature ((Sahani & Bhuyan, 2020)) .On the other hand, some research (Blecˇic, Cecchini, Congiu , Fancello, & Talu, 2020) concentrated on the satisfaction that is the perceived degree of service to the criteria of walkability.

(Kim.et.al., 2014) estimated the effects of environmental factors on the level of satisfaction of utilitarian and recreational walkers, in Seoul, Korea. However, the pedestrian survey includes only one question addressing overall pedestrian satisfaction. In order to sufficiently examine pedestrian satisfaction, various aspects of satisfaction, for example, comfort, safety, ease and aesthetics of walking should be determined.

The results call on researchers to investigate a comprehensive set of psychological and environmental factors, in order to understand the various aspects of pedestrian satisfaction.

(Kim.et.al., 2014) measured the pedestrian level of service within roadside walking environments and investigated major factors affecting the pedestrian level of service by conducting a pedestrian intercept survey. The model developed in the paper has a limitation that it is only applicable to the assessment of the pedestrian LOSs at low pedestrian volumes.

(S. Marisamynathan &. P., 2019) have examined pedestrian perception-based level of service at signalized intersections crosswalk in India. This study has identified several factors which significantly affect pedestrians' perception of safety, convenience, and efficiency while crossing signalized intersections.

(Mateo & Babiano, 2016) have also examined pedestrians' needs for walking environment in Manila, Philippines via face-to-face questionnaire survey and analyzed using Analytic Hierarchy Process (AHP). Based on the survey, the most important priority needs hierarchy for pedestrians is protection, ease, equitable access, mobility, identity, and enjoyment.

(Hidayat.et.al., 2011) presented an alternative model for evaluating the pedestrian level of service at the sidewalk with street vendor activities in Bangkok and Jakarta. Factor analysis is used to summarize pedestrian perceptions into several important variables. Regression models were estimated with pedestrian traffic data to find the level of service.

These studies show that pedestrian flow volume and behaviors are influenced by the accessibility to public transportation, land-use patterns and walking environments (e.g., road width, obstacles, and crosswalk). Some other studies are interested in pedestrian's level of service and safety (Lee, 2012).

Walkability is one of the popular issues in health and welfare which estimates pedestrian's mental condition affected by walking conditions of pedestrian facilities and amenities.

The efficacy of current studies to capture all facets of a facility evaluation process has been a source of worry for a number of review papers and reports. The sidewalk environment, pedestrian characteristics, and flow characteristics are three components that Bloomberg and Burden (2006) have described. The sidewalk environment component is related to the actual, constructed walking environment, the pedestrian characteristics are related to the specific socioeconomic data, behavior, physical capability, and their expectation (users' perception), and the flow characteristics are related to the specifics of the pedestrian and vehicular traffic flow. Given the three main

constructs and how they relate to one another was closely adapted from Bloomberg and Burden (2006). The appraisal of amenities has not, according to Singh and Jain (2011), been inclusive. in terms of the complete "walking environment."

2.6. Sidewalk from Mobility Criteria

Side walk is not only conduits for pedestrian movement and access, but also they enhance connectivity and promote walking. Mobility is the basic requirement of pedestrian facility in addition to safety and accessibility.

According to urban street design guideline, recommend a minimum sidewalk cross-section of 5 feet for residential area, exclusive of other amenities and large enough for two people walking side by side (Boodlal & Leverson, 2003) and (Lowbar & Kayla, February 15, 2013). While this dimension meets minimum ADA accessibility standards, many cities have chosen to adopt wider standards. Sidewalk standards should accommodate higher anticipated pedestrian volumes and provide ample space for an expanded frontage zone as well as other street furniture, such as trash receptacles, bus stops, signage, and bike share stations.

The pedestrian through zone is the primary, accessible pathway that runs parallel to the street. The through zone ensures that pedestrians have a safe and adequate place to walk and should be 5–7 feet wide in residential settings (Sax, et al., 2010) and (Brownson, R. C., E. A. Baker, R. A. Housemann, L. K. Brennan, & S. J. Bacak, 1995-2003) and 8–12 feet wide in downtown or commercial areas (Sax, et al., 2010) and (Brownson, R. C., E. A. Baker, R. A. Housemann, L. K. Brennan, & S. J. Bacak, 1995-2003).

Sidewalks are an essential component of the urban environment and serve as key corridors for people, goods, and commerce. In accordance with ADA accessibility guidelines, sidewalks should be provided on all streets in urban areas. Sidewalks have a desired minimum through zone of 6 feet and an absolute minimum of 5 feet. Where a side walk is directly adjacent to moving traffic, the desired minimum is 8 feet, providing a minimum 2-foot buffer for street furniture and utilities (Sax, et al., 2010), (Lowbar & Kayla, February 15, 2013), (Boodlal & Leverson, 2003) and (Lowbar & Kayla, February 15, 2013).

2.7. Type of models used in pedestrian level of satisfaction assessment and method of pedestrian facility performance evaluation

(Dandan, Wei, Jian, & Yang, 2007) have focused on pedestrian level of service model development at intersections, sidewalks and roadway segments. Since pedestrian level of service is the most common measure of effectiveness in evaluating the walking conditions of existing pedestrian facilities (Asadi-Shekari, Moeinaddini, & Zaly, 2013).

(HCM, 2010) Provided guidance to design and develop pedestrian facilities based on the quantitative measure of pedestrian delay and space requirements in six LOS categories (A–F). Pedestrian Level of Service (PLOS) is a term defining the existing side walking facility operating conditions or suitability for walking mode of transport. Calculation of pedestrian level of service is more complex which represents the operating condition of pedestrian facility and level of comfort pedestrian experiencing. Based on the current practice, pedestrian level of service is determined by two methods such as capacity /mobility method (HCM-METHOD) (Singh K & Jain P.K, 2011)and roadway characteristics-based methods (Sony Sulaksono Wibowo1 & Destri Nurhalima R. M., 2018)

Capacity based methods use the principles of highway capacity which has been suitably adjusted to evaluate pedestrian facilities. They are helpful in planning pedestrian facilities but provide little information regarding acceptability by pedestrians. Roadway Characteristics Based Methods are based on the characteristics of the walkways or

Pedestrian facilities. These methods use pedestrian perceptions and attempt to quantify the comfort level of pedestrians while encountering certain roadway characteristics. In this, study, HCM method had been employed.

2.7.1. Pedestrian method. Level of service by HCM

In this method, pedestrian level of service is determined based on the pedestrian flow rate and the width of pedestrian facility. Based on the concept of HCM-2000 (Singh K & Jain P.K, 2011), “As

volume and density increase, pedestrian speed declines. As density increases and pedestrian space decreases, the degree of mobility afforded to the individual pedestrian declines, as does the average speed of the pedestrian stream."

Based on the method of HCM (Singh K & Jain P.K, 2011), evaluation of the sidewalk level of service uses the calculation of pedestrians per minute per foot (ped/min/ft) as the basis for LOS category. The pedestrian flow rate (ped/min/ft) is obtained by taking the pedestrian 15-minute flow rate (ped/15-min) and dividing by the effective sidewalk width. For calculating pedestrian flow rate, the HCM (Highway Capacity Manual, 2000)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.

Effective width of the sidewalk used in the calculation is obtained by taking the total width of the sidewalk and subtracting obstacle widths and a 1 to 1.5 ft buffer width per obstacle based on (Pushkarev, B., & Zupan, J, 1975).

HCM (2000) explains that the main performance to be measured in assessing PLOS is the space available for walking. The parameters reviewed in this assessment space (ft2/ped) and flow rate (ped/min/ft). For the practicality of field observations, the flow or volume of passing pedestrians can be used as a service measure to assign PLOS from A to F. Based on HCM,2000 (Highway Capacity Manual, 2000), there are six level of pedestrian service which are presented in table below as follows based on flow rate and space provided.

Table 1 :Pedestrian level of service as function of space and flow rate

PLOS	Space(ft2/ped)	Flow rate(ped/min/ft)
A	>60	<=5
B	40-60	5-7
C	24-40	7-10
D	15-24	10-15
E	8-15	15-23
F	>=8	>23

Based on the highway capacity manual (Highway Capacity Manual, 2000) PLOS A implies that pedestrians are “move in desired paths without altering their movements in response to other pedestrians. Walking speeds are freely selected, and conflicts between pedestrians are unlikely”. On this level of service, pedestrians are also can move in staggered pattern just for the purpose of enjoying by covering large space. PLOS B is also implies that pedestrians have sufficient area to select walking speeds freely to bypass other pedestrians, and to avoid crossing conflicts. At this level, pedestrians begin to be aware of other pedestrians, and to response to their presence when electing a walking path. PLOS C is also the same with PLOS B which has also sufficient space for normal walking speeds, and for bypassing other pedestrians in primarily unidirectional streams. However, reverse-direction or crossing movements can cause minor conflicts, and speeds and flow rate are somewhat lower.

Based on the High way capacity Manuel (Highway Capacity Manual, 2000), PLOS D, E, F implies that , they are all not comfortable for any group of pedestrian in terms of mobility and comfort. Especially PLOS E and PLOS F, all are on the failure stage of the facility in terms of capacity and queue is the dominant parameters for such pedestrian level of service facility than other parameters such as speed and flow rate.

(Ni, Ling, & Li, 2013) Most of the existed PLOS models focused on improving pedestrian safety and comfort by considering potential conflicts between pedestrians and vehicles, vehicle volume, left and right turning vehicles, and speed of vehicles.

Recently, researchers have addressed PLOS using qualitative and quantitative data with the qualitative data representing the perception of pedestrian safety and comfort at signalized intersection.

For the design of walkways and stairways, Fruin built the foundation for six levels of service. These service levels provide a qualitative way for developing fresh or assessing current Pedestrian environments (J. J. Fruin, 1971).

According to different urban-street settings, Kang et al. tested how pedestrians perceive line of sight (LOS) on sidewalks shared with bicycles (L. Kang, Y. Xiong, & F. L. Mannering, 2013) Mori et al. (L. Kang, Y. Xiong, & F. L. Mannering, 2013) offered two distinct evaluation methods for regular sidewalks: one based on pedestrian behavior and the other based on pedestrian opinion (M. Mōri & H. Tsukaguchi, 1987).

A foundation was built by AsadiShekari and colleagues for assessing and enhancing campus streets for pedestrians. Based on several criteria that take distinct pedestrian demands into account, they presented pedestrian design indicators. They also created the pedestrian level of service (PLOS) for campuses, a metric for assessing the infrastructure and street facilities for pedestrians on campuses. An analytical point system comparing existing pedestrian facilities to a standard is proposed to estimate this pedestrian level of service.

Rastogi et al. presented the level of service criteria under two conditions, one for pedestrian movements along the carriageway on or at its side and other for the movement on a pedestrian facility. The level of service criteria was developed using two different approaches and the two data sets. One approach is based on the rate of change of curvature of the pedestrian flow-area module curve and another is based on speed ratio-density plot. It is observed that the pedestrian space criterion is more uniform and stable than the pedestrian flow criterion in defining the level of service of a facility (R. Rastogi, S. Chandra, & M. Mohan, 2014).

Based on the measurement of environmental elements, Zhao et al. established a thorough multifactor evaluation technique for pedestrian level of service on sidewalks. The comprehensive evaluation model for the amount of service provided to pedestrians on sidewalks was created using the fuzzy neural network technique (L. Zhao, Y. Bian, J. Rong, X. Liu, & S. Shu, 2016).

Kadali and Vedagiri (B. R. Kadali & P. Vedagiri, 2015) suggested evaluating the level of service provided by such crossing facilities in relation to various land use types when there is mixed traffic. Data on pedestrian perceptions of line of sight (LOS) were gathered for various land uses, including commercial, residential, and retail. The NLOGIT software package was used to construct the ordered probit (OP) model, with the number of cars encountered, the difficulty of the road crossing, and safety being the three main considerations. elements including land-use type, roadway layout, and pedestrian-specific variables like gender and age (B. R. Kadali & P. Vedagiri, 2015)

An extensive study was conducted by Sahani and Bhuyan to establish PLOS criteria for urban off-street facilities in emerging nations with variable traffic flow situations. LOS classification problems are defined using affinity propagation (AP). Through the use of a video camera, inventory information and speed data are gathered from two significant cities in the Indian state of Odisha (Bhubaneswar and Rourkela) (R. Rastogi, S. Chandra, & M. Mohan, 2014)

The technique is based on the unique level of comfort experienced by each pedestrian moving through the region, according to Cepolina et almethodology's for evaluating the quality of operation of pedestrian facilities (E. M. Cepolina, F. Menichini, & P. Gonzalez , 2018)

To compare their LOS planning criteria with those based on Western standards, Tanaboriboon and Guyano created a set of criteria for pedestrian walkway planning in Bangkok (Y. Tanaboriboon & J. A. Guyano, 1996).

Marisamynathan and Lakshmi proposed a method for the evaluation of PLOS at sidewalk, based on quantitative and qualitative data. The required model parameters were collected from video graphic and questionnaire surveys conducted at selected nine sidewalks in Chennai, India. Significant parameters were identified and PLOS model was developed using stepwise regression analysis method. The developed model was validated using the field data and the results showed that the performance level of the proposed model was more precise and produced reliable solutions. The model applications were proposed and analyzed theoretically with three improvement measures. The developed model can be used by road designers to find the wellness of a particular sidewalk that accommodates pedestrian travel mode (S. Marisamynathan & S. Lakshmi, Method to determine pedestrian level of service for sidewalks in Indian context, , 2018).

Based on quantitative and qualitative data, Marisamynathan and Lakshmi established a method for the evaluation of PLOS at sidewalk. In Chennai, India, nine sidewalks were chosen, and video graphic and questionnaire surveys were used to gather the necessary model parameters. The stepwise regression analysis method was used to identify significant factors and create the PLOS model. The generated model was validated using field data, and the outcomes demonstrated that the proposed model's performance level was more accurate and yielded solid results. Three improvement measures were offered for the model applications, which were then theoretically assessed. Road designers can use the established model to analyze whether a given sidewalk is healthy and suitable for pedestrian travel (S. Marisamynatan & S. Lakshmi, Method to determine pedestrian level of service for sidewalks in Indian context, 2018).

In addition to defining threshold values for PLOS classification at signalized junctions, Marisamynathan and Vedagiri created a method that is suitable for estimating the PLOS model under mixed traffic scenarios (S. Marisamynathan & S. Lakshmi, Method to determine pedestrian level of service for sidewalks in Indian context, , 2018)

In India pedestrian facilities such as sidewalks and crosswalks were evaluated with respect to peak hour pedestrian flow, and LOS rating was defined with respect to flow by using IRC 103 (IRC, 2012).

One PLOS model at sidewalk was developed to assess various infrastructure facilities from land use pattern considering pedestrians' perceptions, and the qualitative data-based PLOS model was built by adopting point system techniques (Bivina, Parida, Advani, & Parida, 2018). Another PLOS model Developed for sidewalk by combining qualitative and qualitative data and adopting regression analysis method (Marisamynathan & Lakshmi, 2016).

There are also numerous studies dealing with human factors of pedestrians' crossing behavior, using formal tools such as questionnaires or in-depth interviews. (Hine.J, 1996) used in-depth interviews to identify pedestrians' perception as regards difficulty to cross and assessment of traffic conditions and crossing facilities in the center of Edinburgh.

(Evans & Norman, 1998) developed hierarchical regression models for road crossing behavior, by means of completed questionnaires which included scenarios of three specific potentially dangerous road crossing behaviors. Pedestrians stated crossing behavior was then modeled in relation to measures of attitude, subjective norm, perceived behavioral control, self-identity and intention.

(Yagil, 2000) proposed multivariate regression models for the self-reported frequency of unsafe crossings in relation to beliefs regarding the consequences of the behavior, instrumental and normative motives for compliance with safety rules, and situational factors.

(E.M., 2000) developed a structural equations model for explaining pedestrian risk-taking behavior on the basis of attitude, subjective norm, perceived control, behavioral intention and reported violations, errors and lapses. Self-reported crossing behavior data from pedestrians in the city of Santiago was used on that purpose.

(Holland, & Hill, 2007) tested for age and gender differences in road crossing decisions within a theory of planned behavior analysis including intention, situation and risk perception effects.

(S. Marisamynathan &. P., 2019) tested pedestrian perception-based level of service using user perception and video-graphic surveys during peak hour at signalized intersections. The user

perception survey was conducted that with the help of investigators placed on selected signalized intersections under typical traffic conditions to question about pedestrians' perception on level of safety, convenience, and efficiency while walking along the walk way. In this study fuzzy linear regression model (FLR) was employed to evaluate pedestrian perception.

2.8. Current Trends on Pedestrian Facility

In recent time, the quality of life and well-being has been increased from time to time, due to this reason the paradigm of the transportation sector has been changing from a car-oriented transportation system to an eco-friendly, pedestrian- or all people-oriented urban space mode of transportation (Campisi, Ignaccolo, Inturri, & Tesoriere, 2021) and (Hine.J, 1996). Walking is the most basic means of transportation for all human's type based on their active body movement and is the basis of all activities such as commuting, going to school, work, religious institute, recreational area, and leisure place. In terms of transportation, walking itself is also a form of travel, and it serves as a link between various long travel transportation modes, e.g., buses, railway, taxiway, and subways.

In addition, many studies((Khan & Tiwari, 2007), (Bivina, Parida, Advani, & Parida, 2018), (Adkins, A.,, Dill, J., , Luhr, G., & Neal, M. , 2012) and (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014) claim that walking provides various functions other than transportation modes. For instance, the study conducted in America in state of Oh and Seo argue that the concept of walking in urban design has expanded continuously with the times from the primary means of transportation.

Specifically, the perspective of understanding walking has been expanded as a means of experience and recognition of urban space, a means of leisure, performing social functions, and a monitoring function of public space. KOTI was also emphasizing the eco-friendliness of walking because it relies on human power and has little impact on the environment. In addition, the

literature insists that walking plays a role in bringing novelty and vitality to life in outdoor spaces, going beyond transportation. It contributes to revitalizing the economy of a city or community, promotes social exchange and local economic activities, connects transportation modes, guarantees accessibility, and improves human health. As pedestrians, everyone contributes to ensuring equality in their community and enhancing safety and security.

Different countries and municipal cities are conducted different movement and proclamation to enhance pedestrian movement in urban areas. For instance, in case of South Korea, the recent enactments, such as the Mobility Convenience Promotion Act for the Transportation Vulnerable in 2006 and the Sustainable Transportation and Logistics Development Act in 2009, laid the institutional foundation to vitalize pedestrian transportation that is a non-motorized, carbon-free transportation mode to reduce congestion and greenhouse gas emissions. Furthermore, since the enactment of the Act on Pedestrian Safety and Convenience Promotion in 2015, interest in securing pedestrian rights and the pedestrian environment have increased significantly.

Along with the pedestrian-oriented policy paradigm shift, research to evaluate and analyze pedestrian satisfaction has actively been conducted at different time in different place.

According to several researches conducted by different money scholarches factors of the walking environment that affect pedestrian satisfaction are identified as safety, security, scenery, comfort, and convenience (Asadi-Shekari, Moeinaddini, & Zaly, 2013), (B. R. Kadali & P. Vedagiri, 2015), (Campisi, Ignaccolo, Inturri, & Tesoriere, 2021), (Holland, & Hill, 2007) and (M. Mōri & H. Tsukaguchi, 1987). A case study conducted as investigating the pedestrian satisfaction of traditional markets in Korea classified the influential factors into safety of traveling street, comfort of walking surface, convenience of the place from different area, and interest of individual who are using the street. Besides safety, convenience, and comfort, other studies suggested street

environments, e.g., air quality, noise, natural shade, planting, or street continuity and visibility as evaluation or design elements as conducted by money other studies. Based on the common walkability metrics and attributes from the literature and consideration of the built environment of urban design of the country, this study categorizes factors affecting pedestrian satisfaction into safety, convenience, and comfort to examine differences in satisfaction by land use and street type. Safety implies that the presence of sidewalks, illegal parking, perceived safety level from traffic accidents, illegally placed objects and vehicle travel speed. In case of Convenience: sufficiency of pedestrian guidance facilities, sidewalk material (pavement condition), sidewalk slope, easiness to access public transportation facilities are the main factor to take in to consideration. Comfort is another issue which take in to account the factors such as pedestrian volume, the sufficiency of green space, cleanliness, noise level. Comfort and convince in most studies are correlated with traffic security directly or indirectly.

2.9. Summery Literature Review

In general, pedestrian satisfaction can be classified into pedestrian safety, walking convenience, and comfort. Such satisfaction attributes can be evaluated by a variety of indicators of the presence of sidewalks, illegal parking, the sufficiency of walking space, cleanliness, and so on. On the other hand, it is expected that factors affecting pedestrian satisfaction will differ depending on why and where people walk. For instance, the importance of pedestrian environment factors affecting pedestrian satisfaction may differ depending on travel purpose, such as commuting, school, business, shopping, and leisure. In addition, pedestrian environment evaluation indicators, considered according to the types of pedestrian spaces such as new towns, old downtown, commercial areas, pedestrian paths near stations, and rivers, or differences in land use, such as residential and commercial areas, are different. As pointed out by several researcher, pedestrian

satisfaction involves different facts, i.e., the physical conditions of walking environmental elements and satisfaction level for walking experiences while using them. Many studies dealt with such physical conditions or design elements of the facilities assessed the walkability of various cities in different country. Walkability represents the suitability of an urban environment to provide pedestrian walkways or such environmental features themselves that make it useful, safe, comfortable, and attractive for walking. Improving walkability leads to increasing urban accessibility and travel equity because walking is socially equitable, i.e., it is available to most people non-discriminately. it is the most important especially for elderly or impaired people put different priorities on the elements of walking environments depending on their physical abilities. Despite the various aspects of walkability and different definitions used in the literature, several commonalities can be seen, such as presence and continuity of sidewalks, accessibility of facilities to people with different abilities, directness of pedestrian paths, connections to frequent transit services, ease and safety of crossings, visual interest, and perceived or actual security. On the other hand, other studies focused on the satisfaction that is the perceived level of service to the attributes of walkability. To this end, this study examines factors affecting pedestrian satisfaction according to not only the physical conditions of the walking environment but also the satisfaction level that pedestrians perceive for the individual attributes of design or operational elements. Based on the review of different foreign literature, non-motorized transportation refers to human-powered transportation mainly walking and cycling (Kim, E. J., , Kim, J., , & Kim, H. , 2020). Walking is not only means of transportation mode but also an integral part of physical activity which is very important to maintain good health condition. Walking mode of transport enhance sustainability by making zero emission of gases, it requires low capital and operational cost as compared to other motorized mode of transport, and no more space it requires. Based on the revealed of several

researchers, sociodemographic factors such as gender, age, household income level, and education level have been associated with user behavior toward active transportation usage, walking and cycle (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014) , (Kim, E. J., , Kim, J., , & Kim, H. , 2020), (Williams, G. C., , Borghese, M. M., , & Janssen, I. , 2017), (González, S. A., , Aubert, S., , Barnes, J. D., , Larouche, R., , & Tremblay, M. S. , 2020). In European, American, Asian countries and some African countries have given more emphasize on non-motorized mode of transport since so as to create smart city which can attract more tourism. However, in the country like Ethiopia, particularly Addis Ababa where the degree of urbanization is dramatically increasing from time to time, there is no plan and ambition to emphasize to improve non-motorized mode of transport. As walking and cycling do not require special skills, they are deemed convenient for all age groups, where people manage the intensity of their movements themselves. Walking facility should be walkability in turn continuous, comfortable, affordable, smart and attractive so as to satisfied the pedestrians. Before any walking facility design and construction are provided to the pedestrian, studies are required regarding to the perception of the walking facility they will expect to maximize their satisfaction based on their socio- demographic factor.

3. METHODOLOGY

The main objective of the study is identifying factors which affect pedestrian walking behavior on existing pedestrian facility. Therefore, in this part, the methods following up in order to execute this objective have been described below.

3.1 Description of study area

The study area is located in Addis-Ababa, which is the capital city of Ethiopia and highly crowded by vehicle congestion and walking pedestrians' facility is not safe. Three pedestrian sites are selected for this study such as Megenagna center, Mexico center and Arat kilo footpath. The main reason of selecting these sites is due to more pedestrians available at the whole duration of the day, presence of street market and land use type.

3.1.1 Features of selected area

The selected area in this study is AratKilo area (street), Megenagna Area(street) and Mexico street (area). Each area has their own distinct features such as land use and pedestrian walking type. For more detail, it is shown in table below as follows.

Table 2;Features of selected area

Area/Location	Street Name	Land Use	Side Walk	Street Market
ARATKILO	Aratkilo Street	Institutional/School zone	Not Separated	Yes
MEGENAGNA	Megenagna Street	Commercial	Not Separated	Yes
MEXICO	Mexico street	Institutional/School zone/ Commercial	Not Separated	Yes

Figure 2: Arat killo Walkway

Figure 3: Megenagna Walkway

Figure 4: Mexico Walkway

3.2 Design study

The objective of this study is performance evaluation of existing pedestrian level of service and identifying factors which related to pedestrian walking behavior on existing pedestrian facility. In this part, data sampling method, sample size determination and method of analysis would be described. To meet each specific objective, both factor analysis and logistic regression analysis will be employed in addition to HCM200 method. Factor analysis is employed to identify few factors from original variables which affect pedestrian walking behavior by reviewing of different articles. Logistic regression analysis will be also employed to identify the influence of socio-demographic characteristics of pedestrian on their satisfaction level at existing facility.

3.3 Variables influencing pedestrian walking level of satisfaction

Based on the review of different article conducted in different country; safety, security, mobility and infrastructure, comfort and convenience are found to be the general variables affecting pedestrian walking behavior. Specifically, **safety** (traffic volume and speed), **security** (police patrolling and street lighting), **mobility** (wider side walk, continuous side walk, absence of encroachment, good side walk surface, presence of bus shelters, & presence of road side objects) and **comfort and convenience** (cleanness of side walk and absence of obstruction) were variables related to pedestrian facility.

3.4 Sampling design

The sample size has been determined from pedestrian population using 95% confidence level and 5% precision from at each selected site. The sample size is affected by variability of population, degree of precision and population size. The sample size required for questioner should have always greater than direct field data because the reliability and accuracy is lower than observational and field measurement data. Therefore, another method which is called Cochran's formula for calculating sample size when the population is infinite would be used. Developed a formula to calculate a representative sample for proportions as:

$$n = (z^2 p * q)/(e\text{^}2)$$

Where, n is the sample size,

z is the standard value of corresponding confidence level

p is the succeeded proportion of the population,

q=1-p=un-succeeded proportion and e is level of precision

To get maximum sample size assuming the maximum variability which was equal to 50% (p =0.5) and taking 95% confidence level with ±5% precision.

$$p = q = 0.5, z = 1.96 \text{ and } e = 0.05$$

$$n = (1.96^2 * 0.5 * 0.5)/0.05\text{^}2 = 384.16 = 385 \text{ minimum number of pedstrain.}$$

To account the effect of consistency of data and invalid response, 50 percent of additional pedestrian response will be conduct. Therefore, a total of 600 number of questionnaires will be randomly distributed to pedestrians on selected three sites and, 390 of them are well response and consistent.

3.5 Design of questionnaire

The questionnaire is developed by step by step as follows. First pilot survey was conducted in three selected site to assess the pedestrian towards the level of quality of existing sidewalk and their satisfaction level. The rough questionnaire is developed based on previously conducted study by reviewing of different articles and standardized reports. Then, that rough questions is rephrase again in appropriate way which is more understandable for respondent in both Amharic and English version. Then after, pilot surveys have been conducted to determine the level of easy to answer the questionnaire and complexity of the questions being asked to respondents. Based on the pilot study, the questionnaire has restructured by removing and adding some questions based on the

feedback provided by pedestrians. In general, the structured questionnaire consists of three major parts. The first is socio-demographic characteristics of pedestrian, the belief and attitude about walking and the last is the variables affecting pedestrian walking behavior. The second and the third question is designed using five-point Likert scale which rating from 1 to 5 with corresponding value of strongly agree to strongly disagree.

1. socio-demographic characteristics of pedestrian

1.1. Gender

1. Male 2. Female

1.2. Age of pedestrian

1. Less than 18 2. 18-30 3. 30-50 4. Greater than 50

1.3. Education level of pedestrian

1. Primary school 2. High school 3. Diploma 4. Degree and above

1.4. Health condition of pedestrian

1. Excellent 2. Good 3. Patient

1.5. Purpose of walking

1. Work trip 2. Shopping trip 3. Education trip 4. Recreational trip 5. Others

1.6. Work occupation

1. Private 2. Governmental 3. Entrepreneur

1.7. Income level per month

1. Less than 2000 2. 2000< x <=5000 3. 5000<x<10000 4. Greater than 10,000

2. How extent you satisfied with this" "current pedestrian facility?

1. Very satisfied 2. Satisfied 3. Low satisfaction 4. Not-satisfied

3. How do perceive the following factors related to your level of satisfaction?

3.1. Traffic volume is very low.

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

3.2. Traffic speed is safe.

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

3.3. There are police patrolling and traffic lighting.

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

3.4. I feel safe from vehicle traffic danger

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

3.5. I feel safe from trips, slips and falls

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

3.6. I feel safe from intimidation or physical attack

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

4. There is good mobility in terms of:

4.1. Wider side walk,

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

4.2. Continuous side walk,

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

4.3. Absence of encroachment,

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

4.4. Good side walk,

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

4.5. Presence of bus shelters,

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

4.6. Presence of road side objects.

1. Strongly disagree 2. disagree 3. I don't know 4. agree 5. strongly agree

5. There is Comfort and convenience (cleanness of side walk and absence of obstruction).

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

6. Do you agree that the number of pedestrians in this sidewalk is too large, causing this sidewalk crowded.

1. Strongly agree 2. agree 3. Neutral 4. disagree 5. strongly disagree

3.6 Data collection method

All the necessary data are primary and qualitative data that will be obtain directly from sample of pedestrian population. The questionnaire will be distributed through simple random lottery method in those three selected sites after pilot survey. Simple random lottery method is assuming that, each pedestrian has an equal chance of selection. Based on the questionnaire, the pedestrians are asked about, their mode choice from short to long trip, the main factors affecting their walking mode, level of satisfaction of pedestrian on existing walking facility on selected site and their perception about walking mode of transport at different circumstance. The questionnaire is distributed for admitted and volunteer pedestrians taking some moment with pedestrians for their response. Therefore, a total of 600 questionnaires were randomly distributed to pedestrian and 390 out of 600 were found well response and consistent data. Then after, this will be used for further analysis method which is presented as follows.

For performance evaluation of pedestrian level of service: the data required for this study are traffic data of pedestrian (peak hour flow rate of pedestrian), physical characteristics of side walk facility (effective width of side walk, land use and connectivity) and other utilities provided on the side of side walk. Traffic data of pedestrian had been taken using traffic counting survey supported by video camera. This means that the traffic data had been recorded using video camera for a duration of one hour during morning and evening time when most peak hour movement of pedestrian expected. Then after pedestrian traffic data had been extracted using VLC media player per 15-minute observation time. The physical width of side walking facility had been taken by linear method using tape where as other data (land use and connectivity, and other utilities provided on the side of side walk) had been taken by simple observation by waking along the foot path.

3.7. Data Analysis Method

This section describes the overall data analysis method of the study. For this study both logistic regression and factor analysis would be employed for level of satisfaction of pedestrian and for identifying major factors of walking mode. Ordinal logistic regressions will be employed to know the effect of pedestrian socio- demographic characteristics and external factors on pedestrian level of satisfaction. Factor analysis is also employed to major factors which affect walking mode of pedestrian service.

3.7.1. Ordinal Logistic regression

Logistic regression is non-linear analysis for estimating categorical dependent variable. The dependent categorical variable is level of satisfaction pedestrian. The level of satisfaction of pedestrian is grouped in to three classes which are **not satisfied,** low **satisfaction and better satisfaction**. Therefore, ordinal logistic regression will be employed to know the detail effect of socio-demographic characteristics and external factors on pedestrian level of satisfaction. Logistic regression uses maximum likelihood estimation and it is better since it does not consider assumption of linear regression except multi-collinearity. Multicollinearity is the occurrence of high inter-correlations among two or more independent variables in a regression model. The model has been developed as follows:

Ordinal logistic regression (level of satisfaction-subject)

$$\ln(\text{satisfied}) = b + b1 * X1 + b2 * X2 + b3 * X3 + b4 * X4 + b5 * X5 + b6 * X6 + b7 * X7$$

$$\ln(\text{not} - \text{satisfied}) = c + c1 * X1 + c2 * X2 + c3 * X3 + c4 * X4 + c5 * X5 + c6 * X6 + c7 * X7$$

$$\ln(\text{low Satisfaction}) = d + d1 * X1 + d2 * X2 + d * X3 + d4 * X4 + d5 * X5 + d6 * X6 + d7 * X7$$

Where:

- a, a1, a2….an, b, b1, b2….bn, c, c1, c2….cn, d, d1, d2, d3…dn, e1, e2, e3, e4…, are coefficients of independent categorical variables
- X1, X2, X3, X4, X5, X6 and X7 are independent categorical variables.

3.7.2. Factor analysis

Factor analysis is data reduction method used to re-express multi-variant data with fewer dimension (Kim & Mueller, 1978). The goal of this analysis was used to summarize fewer factors from original pedestrian reason that capture maximum possible information from original factors listed in questionnaire. This method of analysis had been accomplished through factor rotation followed by factor extraction.

Factor extraction is nothing but making choice few numbers of factors from more factors. This few factor was based on trade-off between simplicity and completeness. It was determined using Kaiser Criterion based on the Eigen value of greater than 1 (Kaiser, 1974). Factor rotation is done to making simple structure for grouping each variable and understandable (Ford, Macallum, & Tait, 1986) and (Thurstone , 1947). The rotation of extracted factor was done using orthogonal rotation which used to make factors uncorrelated to each other and easy to understand (Ford, Macallum, & Tait, 1986). Factor analysis have been conducted by using the following procedure.

Step1: Checking the adequacy of the sample

Step2: Ensure Correlation among independent variable

Step3: Extracting factor if both Step1 and Step2 are satisfied

Step4: Rotating the factor

Step5: Assign group name

Then after interpretation which is easy for, operation, management and implementation have been conducted.

Chapter four: Result and Discussion

4.0. Introduction

The main objective of the study is performance evaluation of pedestrian level of service and identifying the endogenous and exogenous factors affecting pedestrian level of satisfaction of existing pedestrian facility on three selected sites of Addis Ababa Road side pedestrian road. This part of the paper presents the result of the study with detail discussion as per the attitude and habit of Addis Ababa pedestrian by comparing with other relevant study done in different country. In this part of the document, descriptive analysis of socio-demographic characteristics of the pedestrian and factors affecting pedestrian level of satisfaction, identifying major factors related to pedestrian walking behavior using factor analysis and logistic regression analysis have and performance evaluation of pedestrian level of service been present in their respective order as follows.

4.1. Descriptive Statistics of socio demographic characteristics of Pedestrians

A total of 390 pedestrian attitudinal survey data have been used for this analysis even if much more amount of questionnaire data is distributed but not all collected. From those who actively participated in the interview, 39.2% of pedestrian was females and 60.8% of them were males' pedestrians. Even if the number of female pedestrians on the selected road site is greater than male pedestrians, most of them are not volunteer to the questionnaire may be due to frustration and other unknown reasons. Based on the raw interview survey, female pedestrians complain more about the security issue of the road especially thieving activity commonly (SHUASHUA). In addition to, security, they are also complaining about the congestion of both pedestrian and vehicle especially during morning and evening time. Male pedestrians are also compliant about non-availability of other transport mode ease them to use walking as mode of transport for short trip.

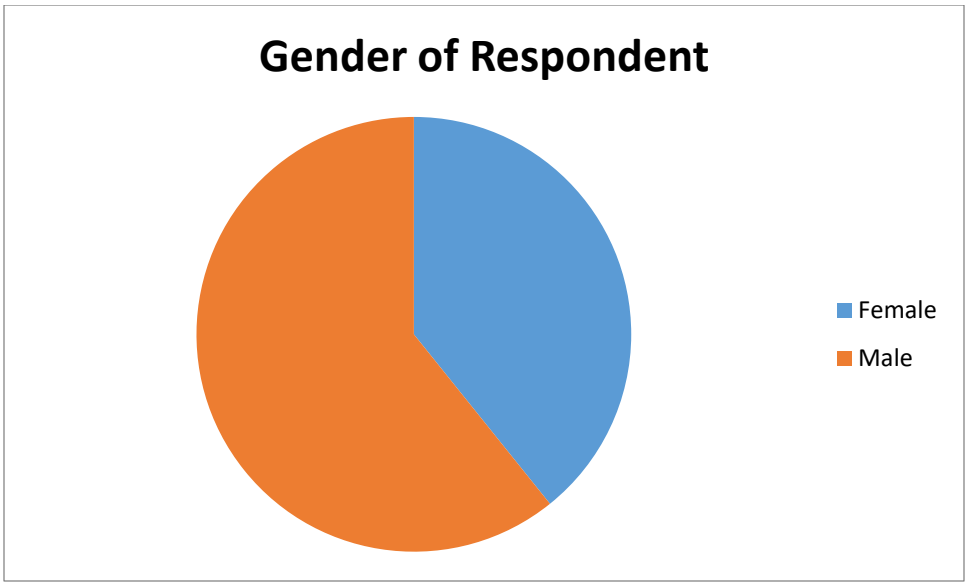

Figure 5: Composition of respondent by gender-category

In terms of age category of pedestrians as shown below in figure 6, pedestrians under the age group of 30 years old have frequently used walking as a mode of transport. Based on the result of descriptive statistics, around 80 % of pedestrians are younger. This maybe they are energetic to walk in order to avoid the queue of vehicle since there is high transport problem in Addis Ababa city especially during morning and evening time. On the other hand, the proportion of older pedestrian is very small as compared to the young age and middle age pedestrian. It is may be due to uncomfortable, unsecured and unsafe situation of existing pedestrian facility or health and energy related problems may be encountered. Most of pedestrians claims that, they are using walking as a mode of transport for home-to-home tripe such as schooling, shopping, recreational tripe and for religious tripe. This descriptive result is also argue with studies done in other country metropolitan cities which have almost similar population number with Addis Ababa based on the literature review (González, S. A., , Aubert, S., , Barnes, J. D., , Larouche, R., , & Tremblay, M. S. , 2020), (Hine.J, 1996) and (Marquet, O., , Hipp, J. A., , & Miralles-Guasch, C. , 2017).

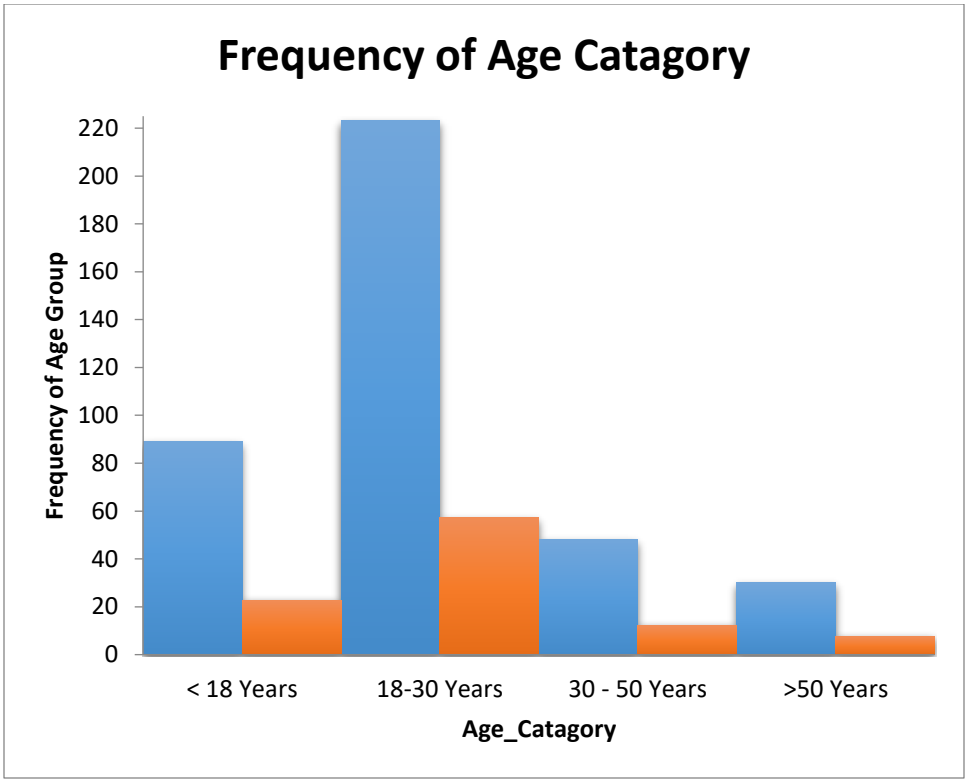

Figure 6: Composition of pedestrian by age category

Based on pedestrian attitudinal survey, most of trip makers have good and better health condition which is contributed about above seventy percent (70%). This means they are doing walking trip not for the purpose of health issue rather for work, educational or shopping activity. Most of previous study conducted in different country such as Korean, Indian and European researchers (Hilland, T. A., , et al., 2020) and (Papageorgiou, G., , Balamou, E., , Efstathiadou, T., , Xergia, S., , & Maimaris, A. , 2018) are concluded that most trip makers are using walking not for health purpose rather persons with health problems are most of the time using motorized for trip since they may not have energy.

Even if the percentage of patient participated in this survey, they are also committed for trip such as educational trip, work trip and shopping trip. Based on descriptive statistics, 26.67,36.15 and 37.18 percentage of pedestrian are using walking for work trip, educational trip and shopping trip respectively. This assured that most of residents are using walking as mode of transport for the following activity such as schooling, shopping, recreational and for religious tripe to save time and cost. For more detail, it is presented as follows in graph form as shown below.

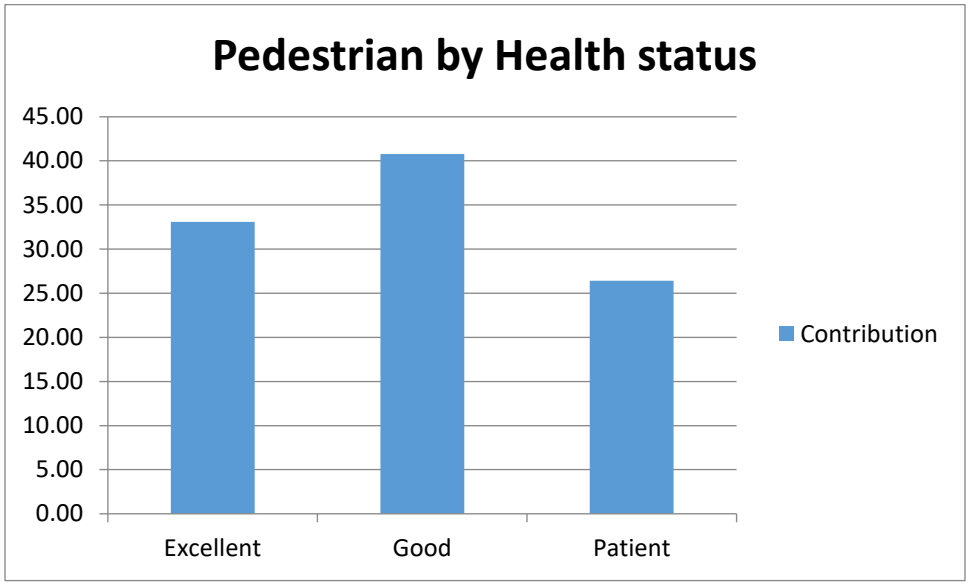

Figure 7: Composition of pedestrian by health status

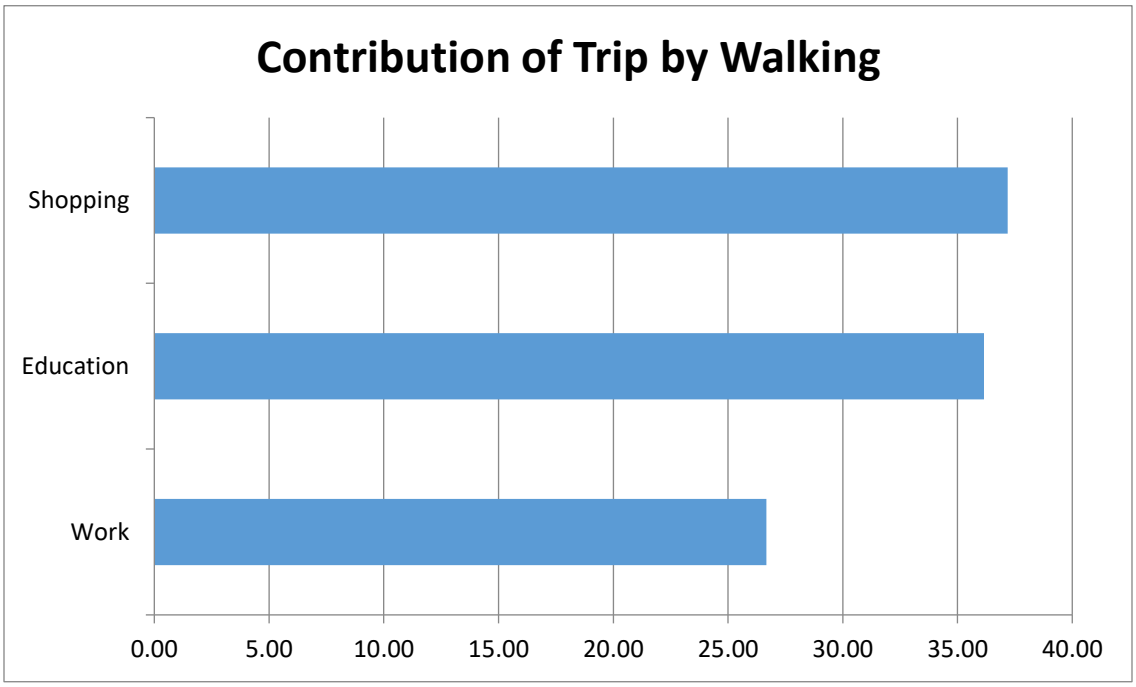

Figure 8: Composition of trip by walking

Based on the analysis of descriptive statistics as shown below figure_9, most of walking-based trip makers are single or un-married which contributed about 62% of all pedestrian, and most of them are doing walking for the purpose of shopping and education. They have also medium to low-income level which are un-able to own car or shared vehicle since economy problem but they have enough time to do walking.

In context of Ethiopia, particularly in Addis Ababa, most of single or un-married are using walking as a mode of transport rather than other mode of transport, since they prefer walking by talking with the proposed boy or girl friends to be free from other circumstance.

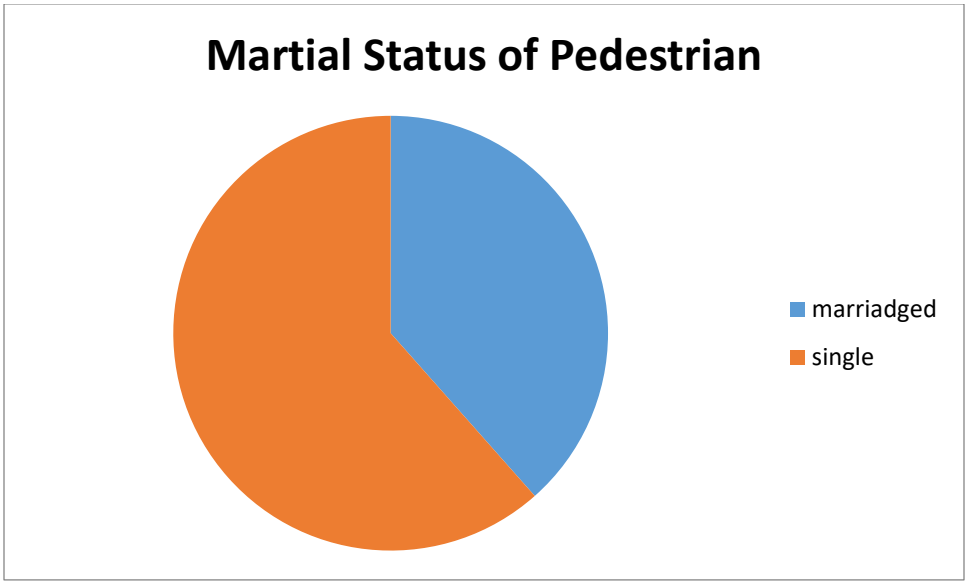

Figure 9: Composition of pedestrian by marriage status

Based on the perception of pedestrian attitudinal survey as shown below figure_10, most of trip makers have very low-income level as compared to the current condition which contributed to 59% of all pedestrian. Even if their option of mode of transport is walking, the facility has different problems such as security problem, traffic safety problem, road lighting problem during night and crowded pedestrian, as claimed by participating pedestrians. Based on the opinion of respondent, some percentages of respondent are using walking as a mode of transport due to non-availability or shortage of other mode of transport.

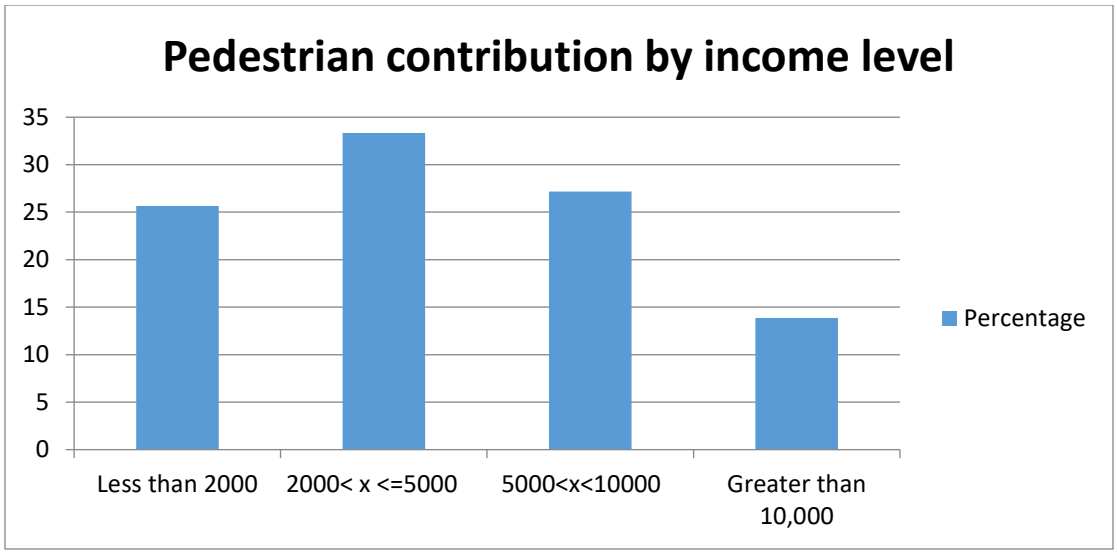

Figure 10: Composition of pedestrian by income level

Based on the perception of pedestrian, most of pedestrians are claimed that they are not always using walking as a mode of transport for any activity. This is because during night time road user commuters are finding public transport, taxis or any other ride vehicle as a mode of transport due to security problem and long-distance travel. Due to this reason, above 71% of residents are using walking sometimes or rarely. The main reason of it is the duration of trip is long far, and the pedestrian facility is unsafe and un-able to accommodate all pedestrian. As per the attitudes of pedestrian, they are using walking rarely as a mode of transport during non-availability of other modes of transport, most of the time Sunday and some holidays if there are great traffic congestion.

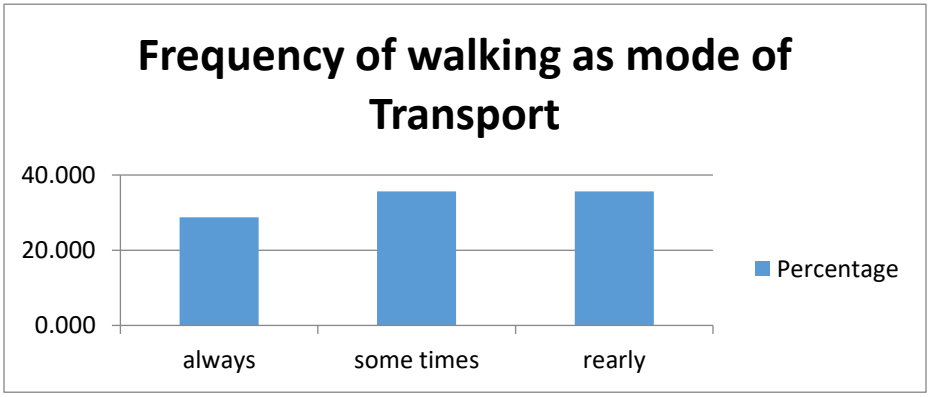

Figure 11: Frequency of walking used by pedestrian

4.2 Satisfaction of pedestrian on Existing Facility

The satisfaction level of pedestrian on existing pedestrian facility was rating from using five-point rating scale with corresponding value of highly satisfied to never satisfied. However, in order to get meaningful, result of the study and implementation, the four-point rating have been changed to three-point rating and binary choice form depending on the situation.

Based on grouping, the three-point groupings are, better satisfaction levels, Lower satisfaction level and not satisfied at all. This level of satisfaction of the pedestrian is depend on socio-economic demographic characteristics of the pedestrian and external factors associated with security, safety, comfort, and convenience of provided facility.

The associations between pedestrian level of satisfaction and the corresponding socio-demographic factors and external factors have been shown using logistic regression and two-way comparison methods. The binary choice of the pedestrian is whether they are satisfied or not – satisfied on existing pedestrian facility.

Based on the questionnaire attitudinal survey of the pedestrian as manipulated from excel table_1, 36.41, 34.87 and 28.72 percentage of pedestrian are not satisfied, lower satisfaction and better satisfaction respectively. This implies that almost, most pedestrians are under expected satisfaction level of pedestrian due to low tendency of pedestrian for walking, un-availability of enough pedestrian facility which could accommodate the demand of the pedestrian or (safety, security, comfort and convenience) problem of pedestrian facility.

Even if the magnitude or degree of satisfaction of pedestrian are high in the context of Ethiopia particularly in Addis Ababa is high, there is expected level of dissatisfaction in other foreign countries city due to having low tendency of pedestrian for walking, un-availability of enough pedestrian facility which could accommodate the demand of pedestrian or (safety, security, comfort and convenience) problem of pedestrian facility based on previous other similar study such as (Blecˇic, Cecchini, Congiu , Fancello, & Talu, 2020), (Bivina, Parida, Advani, & Parida, 2018), (Jamal, S., & Mohiuddin, H. , 2020) and (Williams, G. C., , Borghese, M. M., , & Janssen, I. , 2017). From those unsatisfied pedestrians most of them are females, with unmarried and having low-income level.

Table 3: composition of satisfaction level of the pedestrian

Level of Satisfaction	Frequency	Satisfaction Level
Not Satisfied	142	36.41
Lower Satisfaction	136	34.87
Better Satisfaction	112	28.72

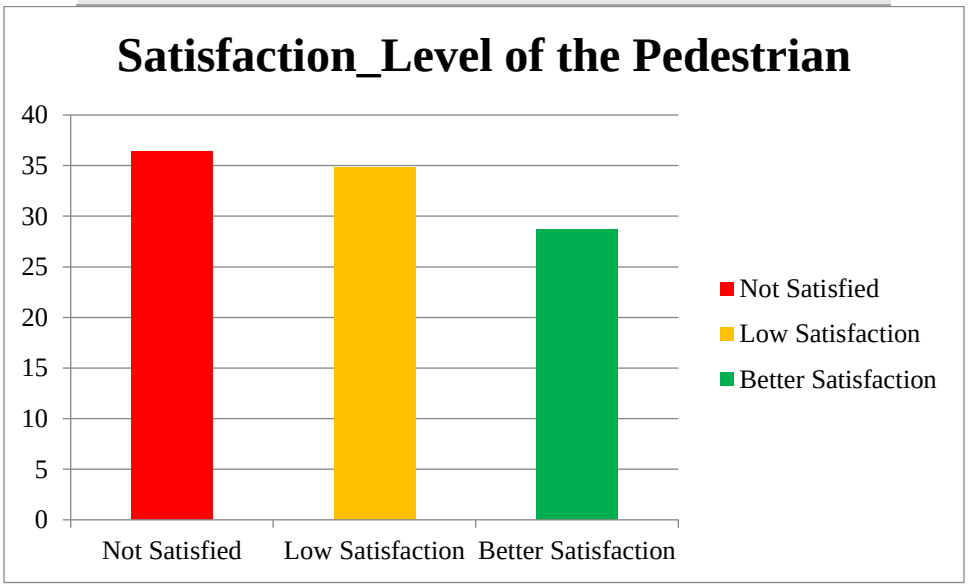

Figure 12: Satisfaction level of the pedestrian on existing walking facility

When the perception of pedestrian is rating as satisfied or not, on selected existing pedestrian facility, 71.28 percentage of the pedestrian are under satisfaction or not satisfied. Most of the pedestrian which are under satisfaction are females, below medium income level and more frequently used walking as a tripe mode.

Table 4: Condition of satisfaction

Condition of Satisfaction	Frequency	Percentage of Satisfaction
UN_ Satisfied	278	71.28
Satisfied	112	28.72

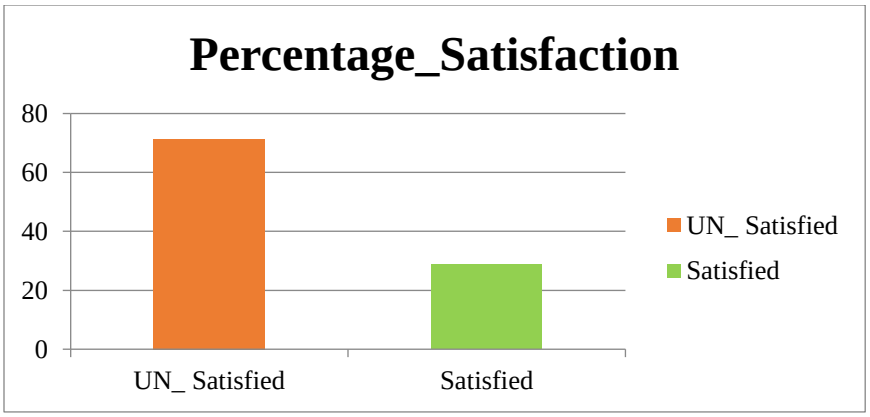

Table 5: Percentage of satisfaction on existing pedestrian facility

4.3. External factors affecting the perception of pedestrian satisfaction level

Based on the perception of pedestrian attitudinal survey as shown in the below mentioned table_4, F3 (Jammed sidewalk) with mean value of 1.39 implies that the main factor for almost all type of pedestrian affecting their level of satisfaction with 0.85 and 0.883 Skewness and kurtosis respectively. It means that they are not normally distributed.

Based on the kurtosis and skewness value of all included factors, they are not normally distributed implies that we cannot use linear regression analysis rather than logistic regression. Standing from this analysis, logistic regression has been employed after factor analysis.

Based on the perception of the pedestrian attitudinal survey, due to congestion of side walk during evening time and morning time the pedestrians are exposed for unwanted delay and feels discomfort. This result is also argue that with different studies conducted by several researcher in different countries about the main case which affect the desired satisfaction level of the pedestrian on using walking for different tripe purpose ((Hine.J, 1996), (Bernhoft & Carstensen, 2008), (Adkins, A.,, Dill, J., , Luhr, G., & Neal, M. , 2012), (Adkins, A.,, Dill, J., , Luhr, G., & Neal, M. , 2012) and (Asadi-Shekari, Moeinaddini, & Zaly, 2013).

This may lead the commuter to find other option just like waiting taxi by making line queueing which is the main cause of over-crowded or jammed of vehicle road. This type of problem may be solved by providing pedestrian facility that able to accommodate the peak hour pedestrian volume, even if there is no enough space available, it is recommended to reduce the width of the carriageway replace with pedestrian and cycling facility since they are environmentally friend and zero-emission as approved by different study (Chung, 2012), (Lee, 2012), (Y. Tanaboriboon & J. A. Guyano, 1996) and (Ji & Gu, 2011).

Table 6: ***Descriptive Statistics of External Factors affecting pedestrian satisfaction***

External variable	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14
Sample saize(N)	390	390	390	390	390	390	390	390	390	390	390	390	390	390
Mean	2.92	4.02	1.39	2.31	2.14	4.00	2.96	2.41	3.26	2.88	3.21	2.89	2.88	2.97
Std. Deviation	0.768	0.845	0.534	0.480	0.867	0.880	0.929	0.714	0.526	0.799	0.668	0.787	0.795	0.828
Skewness	0.850	-0.244	1.201	0.611	0.085	-0.27	-0.47	-0.67	0.19	0.651	-0.26	0.711	0.67	0.74
Std. Error of Skewness	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124
Kurtosis	0.883	-1.09	2.24	-1.08	-1.02	-1.09	-0.75	-0.59	-0.4	1.02	-0.79	1.057	1.0	0.5
Std. Error of Kurtosis	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247

4.4. Factor Analysis

For this study, factor analysis method is used to reduce 14 numbers of variables which are influencing walking mode choice of pedestrian into small number of factors which is easy for interpretation and management. The main objective of this analysis method is extracting few factors in which they have maximum common variance from all 14 walk way related external factors and, only few factors (grouped principal components which obtained from factor analysis) are used for further analysis. The analysis method is presented as follows in sequence of their order.

4.4.1 Adequacy of the sample and sufficient correlation among variable

The first step of factor analysis is assured the adequacy of the sample and sufficient correlation among the variable, if not the analysis should not be conducted. According to Kaiser-Meyer-Olkin sampling adequacy technique the KMO value should be greater than 0.8 (Kaiser, 1974), implies

that, pedestrian related factors have adequate sample to carried out factor reduction. At the same time, the walking facility related factors have also sufficient correlation among variables which is P (Chi-Square (4399.855, df (91)) =0.000. For more detail the correlation between independent variables are presented in the correlation table below. Most of them are correlated each other significantly.

Based on the result of analysis, as shown below in table _ 5 the KMO (Kim & Mueller, 1978) and (Kaiser, 1974) value is 0.833 which greater than 0.8, mean that the sample is adequate for factor analysis. All 14 factors have found also sufficient correlation among each other that meet requirements factor analysis

Table 7: Checking sample adequacy and correlation among the factor

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.833
Bartlett's Test of Sphericity	Approx. Chi-Square	4399.855
	Df	91
	Sig.	.000

Based on the result of correlation matrix table as shown below, almost, all factors have significant correlation among each other as per Pearson correlation coefficient.

4.4.2 Factor Extraction

The factor has been extracted based on the communality value, factors or components which have greater than 0.4 values are extracted since factors under 0.4 have not more influence as per Kaiser (Kim & Mueller, 1978). Communality is a term in factor analysis which revealed that a proportion of common variance found in particular variable (Kim & Mueller, 1978). The value approach to one indicates that no unique variance and zero indicates that no common variance. That means since the presence of more correlation among pedestrian perspective factors, the information found in one pedestrian (walking environment, Physical factor, traffic factor and security) related factor found another corresponding factor based on communality. All factors which have below 0.4 (Kim & Mueller, 1978)communality have not been extracted since no common information. However,

all factors are extracted since the communality is greater than 0.4 values. The extraction method employed for this analysis is principal component analysis.

Table 8: Factor extraction using principal component analysis

Walking variables	*Initial*	*Communality*	*Unique variance*
F1	*1.000*	*.941*	0.059
F2	*1.000*	*.684*	0.316
F3	*1.000*	*.604*	0.396
F4	*1.000*	*.846*	0.154
F5	*1.000*	*.807*	0.193
F6	*1.000*	*.707*	0.293
F7	*1.000*	*.636*	0.364
F8	*1.000*	*.533*	0.467
F9	*1.000*	*.660*	0.34
F10	*1.000*	*.891*	0.109
F11	*1.000*	*.603*	0.397
F12	*1.000*	*.926*	0.074
F13	*1.000*	*.898*	0.102
F14	*1.000*	*.865*	0.135
Extraction Method: Principal Component Analysis.			

4.4.4. Variance of principal component

Factor analysis is a statistical tool used to determine the variability among observed variables (Kaiser, 1974). Variance is the numerical value used to identify the variability of factors related to walking mode of transportation (Kim & Mueller, 1978). After all analysis, four factors have been extracted based on Eigen value greater than 1. Eigen value greater than one implies that, the component holdup information more than one variable that affect pedestrian walking behavior (Kaiser, 1974). The extracted factors are presented in screen plot form as follows based on Eigen

value and variances they can explain as shown in table below. Based on eigen values, four factors have been extracted from all fourteen factors which have greater than one eigen value.

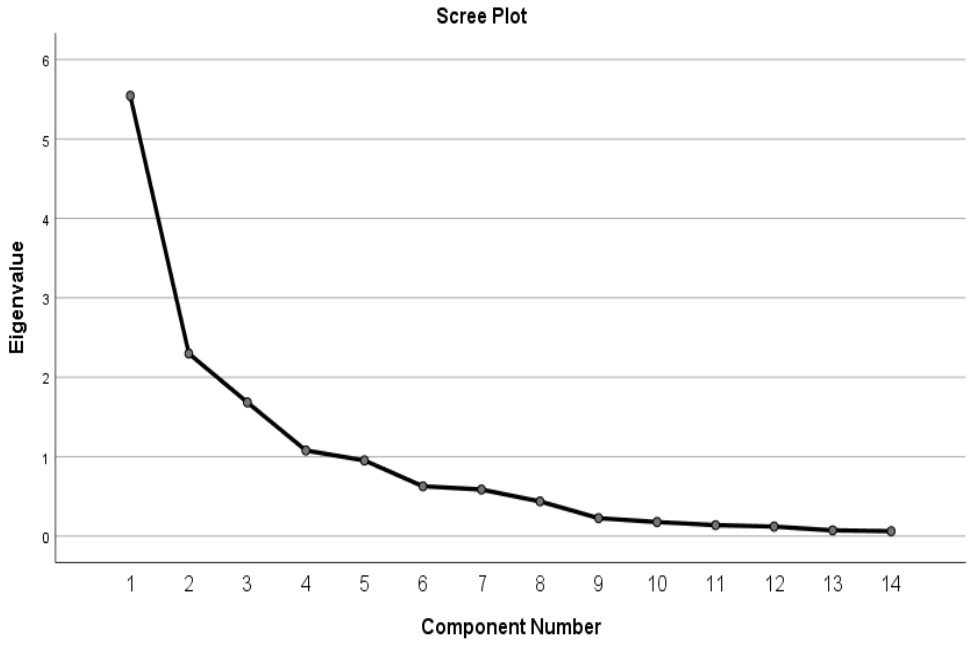

Figure 13: Principal component screen plot

Table 9: Variance of principal component factor

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.5	39.6	39.6	5.5	39.6	39.6	4.6	32.6	32.6
2	2.3	16.4	56.0	2.3	16.4	56.0	3.0	21.3	53.8
3	1.7	12.0	68.0	1.7	12.0	68.0	1.9	13.5	67.3
4	1.1	7.7	75.7	1.1	7.7	75.7	1.2	8.4	75.7
5	1.0	6.8	82.5						
6	0.6	4.5	87.0						
7	0.6	4.2	91.2						
8	0.4	3.1	94.3						
9	0.2	1.6	95.9						
10	0.2	1.3	97.2						
11	0.1	1.0	98.2						
12	0.1	0.9	99.0						
13	0.1	0.5	99.6						
14	0.1	0.4	100.0						

Based on the above table_7, four factors are selected that could have explain 75.7% of total variance which is efficient and significant factor. Then after the factor should be rotated perpendicularly in order to avoid the correlation of one factor to another factor as shown in table_8 below. Based on rotation, Factor1 includes (F1, F10,F12,F13 and F14 or [Jammed sidewalk ,Wider side walk, Continuous side walk, Good side walk, Presence of road side objects and other activity respectively]) ,Factor2 (F3,F4,F5,F6 with corresponding name of ,Traffic volume is very low, Traffic speed is safe, police patrolling and traffic lighting and feel safe from vehicle traffic danger respectively), Factor3 (F7,F8 and F11with corresponding name of ,Presence of bus shelters, feel safe from intimidation or physical attack and Absence of encroachment respectively) and Factor4 (F2 and F9 with corresponding name of Absence Comfort and convenience and feel unsafe from trips, slips and falls respectively). Factor1 is the dominate one that hold up more information which contribute about 32.6% of total variable but the number of variables included in it is 5. Factor2 is the second principal component that can explain the total information of 21.3%. Factor four is holding up the information of two variables which contributed about 8.4% of total variance.

Table 10: Rotated principal component factors

	1	2	3	4
F1	.943			
F2				.563
F3		.667		
F4		-.816		
F5		.848		
F6		-.823		
F7			.789	
F8			.683	
F9				.805
F10	.925			
F11			.749	
F12	.944			
F13	.937			
F14	.913			

The coefficient of each variable on the selected principal component shows the effect of each variable on the group factors.

$$Factor1 = 0.22F1 + 0.22F10 + 0.226F12 + 0.23F13 + 0.22F14$$

$$Factor2 = 0.27F3 - 0.261F4 + 0.308F5 - 0.336F6$$

$$Factor3 = 0.451F7 + 0.366F8 + 0.426F11$$

$$Factor4 = 0.425F2 + 0.730F9$$

Table 11: Component Score Coefficient Matrix

	Component			
Variable	1	2	3	4
F1	.220	-.034	-.016	.007
F2	.032	-.160	.113	.425
F3	-.042	.267	.107	.269
F4	.029	-.261	-.012	.193
F5	-.046	.308	.063	.072
F6	.060	-.336	.117	-.154
F7	-.055	-.042	.451	-.115
F8	-.009	-.029	.366	.127
F9	.006	.123	-.087	.730
F10	.221	-.040	-.036	.006
F11	-.076	.033	.426	-.106
F12	.226	-.046	-.029	.015
F13	.231	-.057	-.049	.004
F14	.219	-.046	-.033	-.002

After factor are extracted and rotated which is simple for management and interpretation, the extracted factor should be uncorrelated each other as shown in table below.

Table 12: Component Score Covariance Matrix

Component	1	2	3	4
1	1.000	.000	.000	.000
2	.000	1.000	.000	.000
3	.000	.000	1.000	.000
4	.000	.000	.000	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser
Normalization

The factor analysis has been conducted using principal component analysis and the rotation method is Varimax with Kaiser Normalization (Kim & Mueller, 1978) which makes absolutely independent one factor among another factor.

In general, the following group of variables should need great consideration in order to create safe, green, zero-emission and sustainable transport system in Addis Ababa town by giving great consideration for the pedestrian just like what is done for public transport. Because walking mode of transport is the most and the first means of achieving and creating smart city. Therefore, consideration should be based on the level of variance.

First, adequate pedestrian walk way should be provided without any type of physical distraction; second, the walking facility should be separated from vehicle road by traffic barrier, third, appropriate passing and encroachment should be provided based on international standard; and the last is making the surface comfortable for walking. In order to create livable and smart city, the facility of pedestrian should be free from problems such as walking facility problem, Traffic Safety problem, security problem and, Comfort and convenience issues.

All above aforementioned problems are co-exist in Addis Ababa city urban roads especially Aratkilo Street, Megenagna Street and Mexico streets. It is possible to say most urban roads of Addis Ababa have not complete pedestrian walk way. Even though, pedestrian walk way are provided somewhere, most of them are 3m walkway width by default which is negligible as compared to the volume of pedestrian. The volume of pedestrian on such a selected pedestrian segment is very high, so the provided width of walk way should meet the peak hour demand of the pedestrian, and the design and the provided pedestrian facility should have traffic barrier that can prevent from runout vehicle or errant vehicle.

All the aforementioned problems are considered as the main problem in western country also based on different study (Dandan, Wei, Jian, & Yang, 2007), (Asadi-Shekari, Moeinaddini, & Zaly, 2013), (Campisi, Ignaccolo, Inturri, & Tesoriere, 2021), (E.M., 2000), (Chung, 2012) and (Hidayat.et.al., 2011).

When we compare and contrast, the western country pedestrian walkway with Addis Ababa as the second diplomatic city in the world next to New York, it is almost possible to say no pedestrian

facility as compared to 60% of Addis Ababa city resident is commuter to walking (AATMA, 2019) . Not only in terms of (traffic safety, security and comfort and convenience) which is the most dominant group of factor based on this study and other previous similar study (Khan & Tiwari, 2007) (Seong, E. Y., , Lee, N. H., , & Choi, C. G, 2021), (Mateo & Babiano, 2016) and (Young, D. R., et al., 2020), but also there is no pedestrian facility that can meet the demand of pedestrian, that is why Megenagna walkway, AratKilo walkway, and Mexico walkway is always crowded based on observational survey.

The following factors such as (traffic safety problem, security problem and comfort and convenience problem) are very important not only to achieve the desired level of satisfaction of pedestrian but also for urban mode choice as described by different previous study (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014). If the pedestrian walk way is wide with comfortable surface and free from any type of problem such as security issue and crowded, that is attractive not only for existing pedestrian but also create mode shift from motorized mode of transport to Walking what is currently called Active mode of Transport (González, S. A., , Aubert, S., , Barnes, J. D., , Larouche, R., , & Tremblay, M. S. , 2020),and (E. M. Cepolina, F. Menichini, & P. Gonzalez , 2018), (Jamal, S., & Mohiuddin, H. , 2020).

Based on the result of this study in portion of factor analysis, walking facility problem (narrow pedestrian facility that cannot accommodate the peak hour demand of pedestrian, crowded pedestrian volume and Dis-continuous side walk with road side object) are found to be the most dominant factor which could have explain the total variance of 32.6%. Because, if the walking facility is crowded, it makes delay of pedestrian on existing pedestrian facility and will be the case of disruption of their work and may not get freedom during walking.

Walking facility problem is uncommon in western country by influencing the degree of satisfaction level of pedestrian since unless the quality of pedestrian facility, there is no shortage of pedestrian facility unlike our country particularly Addis Ababa (Asadi-Shekari, Moeinaddini, & Zaly, 2013) (J. & N., 170), (Jamal, S., & Mohiuddin, H. , 2020) and (Kim.et.al., 2014).

The second dominant factor in Addis Ababa city pedestrian facility is traffic safety problem which explain 21.3% of the total variance. For instance, most of the available pedestrian facility of Addis Ababa are unprotected by traffic barrier from errant or runout vehicle if any and cause pedestrian traffic accident. If the pedestrian facility is unprotected from vehicular road, pedestrians are fear

by assuming if the vehicle is run-out and injured me and abstain themselves using that unprotected pedestrian facility based on social physiology (Evans & Norman, 1998).

Pedestrians are the first and the most vulnerable road user on Addis Ababa Street which account 80% of total fatal Accident based on the yearly annual report of Addis Ababa traffic management agency (AATMA, 2019). However, the fatality rate of pedestrian in western and eastern countries are very low because most of pedestrian facilities are protected with well-known flexible traffic barrier and, safe for example **Slovakia** (Rišová, K., & Madajová, M. S. , 2020), **North Korea** (Kim.et.al., 2014) and **China** (Bian, Ma, & Rong, 2009).

Table 13: Coefficient of variable on each factor

Factor1	Coefficient Of factor	Variance	Given Name
Jammed sidewalk	0.22	32.6	Walking facility
Narrow side walk,	0.22		
Dis-continuous side walk,	0.23		
Good side walk surface,	0.23		
Presence of road side objects and other activity	0.22		
Factor 2			
Traffic volume is very low.	0.27	21.3	Traffic Safety
Traffic speed is safe.	0.26		
There is police patrolling and traffic lighting	0.308		
I feel safe from vehicle traffic danger	0.336		
Factor 3			
Presence of bus shelters,	0.451	13.5	security
I feel safe from intimidation or physical attack	0.366		
Absence of encroachment	0.426		
Factor 4			
Absence Comfort and convenience	0.425	8.4	Comfort and convenience
I feel unsafe from trips, slips and falls	0.73		

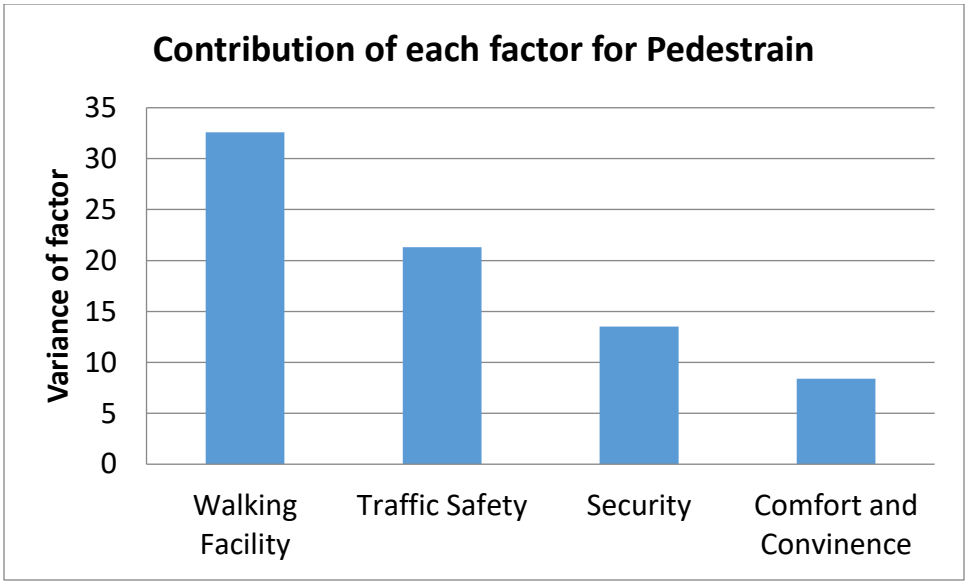

Table 14: Contribution of each factor for pedestrian level of satisfaction

4.3. Logistic Regression

Binary logistic regression has been employed to identify factors which influence the satisfaction of pedestrian on existing facility. The dependent variable is binary option **satisfied** or **not satisfied** which rating 0 or 1 respectively. The explanatory variable includes the major principal component that found from factor analysis such as walking facility (Factor1), Traffic safety (Factor2), Security (Factor3) and Comfort & Convenience (Factor4). For more detail, the descriptive statistics is presented as follows.

Table 15: Descriptive Statistics of explanatory variable

Variable	Observation	Mean	Std. Dev.	Minimum	Maximum
Binary choice	390	0.53	0.50	0	1
Factor1	390	2.91	0.76	1	5
Factor2	390	2.46	0.26	1	5
Factor3	390	2.86	0.59	1	5
Factoor4	390	3.64	0.53	1	5
AGE category	390	2.12	0.91	1	4
Education level	390	1.53	0.76	1	4
Marriage status	390	0.62	0.49	0	1
Health condition	390	1.94	0.77	1	3
Income level	390	2.29	1.00	1	4

Gender	390	0.61	0.49	0	1
Purpose of walking	390	2.11	0.79	1	4
Frequency of walking	390	2.07	0.80	1	3

4.3.1. Correlation between Dependent and Independent Variable.

Before conducted logistic regression analysis, multi-collinearity among independent variable should be checked because redundant variable (variables contain the same information) should not be included in the pedestrian satisfaction model. The multi-collinearity among dependent variable have been checked using Pearson correlation coefficient as shown in table below.

Table 16: Pearson correlation coefficient

Variables	Binary choice	Factor1	Factor2	Factor3	Factoor4	AGE	Education	Marriage	Health condition	Income level	Gender	Purpose of walking	frequency of walking
Binary choice	1.00	-0.18	-0.16	-0.11	0.09	-0.12	-0.05	-0.12	0.05	0.16	-0.10	0.01	0.01
Factor1	-0.18	1.00	0.14	0.24	-0.15	-0.05	-0.05	-0.23	-0.15	-0.18	0.38	0.00	-0.05
Factor2	-0.16	0.14	1.00	0.26	0.20	0.13	0.08	0.24	-0.04	0.06	-0.03	0.06	0.14
Factor3	-0.11	0.24	0.26	1.00	0.08	0.05	-0.06	-0.04	-0.09	0.13	0.00	0.12	0.08
Factoor4	0.09	-0.15	0.20	0.08	1.00	0.11	-0.09	0.33	0.13	0.21	-0.35	0.09	0.10
AGE	-0.12	-0.05	0.13	0.05	0.11	1.00	0.27	0.40	0.39	-0.08	0.07	-0.09	-0.18
Education	-0.05	-0.05	0.08	-0.06	-0.09	0.27	1.00	0.12	0.12	-0.28	0.00	-0.10	-0.16
Marriage	-0.12	-0.23	0.24	-0.04	0.33	0.40	0.12	1.00	0.24	0.10	-0.33	-0.07	-0.07
Health condition	0.05	-0.15	-0.04	-0.09	0.13	0.39	0.12	0.24	1.00	0.16	-0.25	0.00	-0.01

Income level	0.16	-0.18	0.06	0.13	0.21	-0.08	-0.28	0.10	0.16	1.00	-0.43	0.24	0.43
Gender	-0.10	0.38	-0.03	0.00	-0.35	0.07	0.00	-0.33	-0.25	-0.43	1.00	-0.07	-0.17
Purpose of walking	0.01	0.00	0.06	0.12	0.09	-0.09	-0.10	-0.07	0.00	0.24	-0.07	1.00	0.54
frequancy of walking	0.01	-0.05	0.14	0.08	0.10	-0.18	-0.16	-0.07	-0.01	0.43	-0.17	0.54	1.00

4.3.2. Ordinal Logistic Regression

Ordinal logistic regressions have been developed for pedestrian to evaluate their level of satisfaction on existing facility. In this case, level of satisfaction is categorized in to three category which are rating from satisfied, low satisfaction and not satisfied by replacing the ordinal number1,2 and 3 respectively.

The main principal component variables such as Factor1(walking facility problem), Factor2(Traffic Safety), Factor3 (security problem) and Factor4 (comfort and convenience) are taken as continuous variable whereas socio-demographic characteristics are coded as categorical grouped variable based on the interval of previous studies and international studies and reports (Hilland, T. A.et al., 2020), (Khan & Tiwari, 2007), (Holland, & Hill, 2007), (Bernhoft & Carstensen, 2008) and (E. M. Cepolina, F. Menichini, & P. Gonzalez , 2018).

The model is presented as shown in table_15 below based on statistical analysis output. Most of socio-demographic characteristics are categorical variable are included in the ordinal logistic regression model, however, some categorical classes in group of independent variables are not found significant variable but which are found the critical influential factor in other western and eastern international studies.

Based on the result of ordinal logistic regression analysis, the model has showed excellent improvement as compared to null model which indicates that 41.34% improvement Pseudo R@2 according to statistical notification of (Kaiser, 1974) statistical logic. The model is significant based on the probability of (LR chi2(6) = 48.83 and P=0.000). Therefore, the selected factor is not

only important but also significant for upcoming pedestrian facility which is to be designed and constructed if this and other similar studies are under consideration.

Table 17: Logistic Regression Model out put

Group variable	Categorized Variable	Coefficient	Std. Error	Wald	Df	Sig.
Intercept	Not Satisfied = 1	-7.276	2.136	11.606	1	0.001
	Low Satisfaction=2	-3.991	2.094	3.632	1	0.057
	Better Satisfaction=3	0[a]				
Age Category	[AGE=1]	1.657	0.669	6.134	1	0.013
	[AGE=2]	1.180	0.490	5.795	1	0.016
	[AGE=3]	-0.543	0.631	0.741	1	0.389
	[AGE=4]	0[a]				
Education Category	[Education=1]	-4.292	1.914	5.028	1	0.025
	[Education=2]	-4.771	1.676	8.102	1	0.004
	[Education=3]	-4.033	1.704	5.601	1	0.018
	[Education=4]	-4.546	1.726	6.932	1	0.008
	[Education=5]	0[a]			0	
Marriage Status	[Marri aged=1]	0.411	0.410	1.005	1	0.316
	[Single=0]	0[a]			0	
Health Condition	[Not Good=1]	0.100	0.446	0.051	1	0.822
	[GOOD=2]	-0.676	0.399	2.878	1	0.090
	[Excellent=3]	0[a]			0	
Income Level	Very low=1	-0.997	0.508	3.852	1	0.050
	Low=2	-1.315	0.446	8.703	1	0.003
	Intermediate=3	3.896	0.580	45.069	1	0.000
	High=4	0[a]			0	
Gender	Female=1	0.371	0.423	0.766	1	0.381
	Male=0	0[a]			0	

Tripe purpose	Work Tripe=1	-2.882	0.381	57.231	1	0.000
	Education Tripe=2	-0.977	0.330	8.749	1	0.003
	Shopping Tripe=3	0[a]			0	
Walking facility Problem	[Factor1=3.0]	1.532	0.717	4.569	1	0.033
	[Factor1=3.2]	2.470	1.086	5.171	1	0.023
	[Factor1=4.0]	1.573	0.853	3.400	1	0.065
	[Factor1=5.0]	0[a]			0	
Traffic Safety problem	[Factor2=2.75]	-3.370	1.342	6.304	1	0.012
	[Factor2=3.25]	0[a]				NS
Security problem	[Factor3=1.3]	18.371	6218.123	0.000	1	0.998
Comfort and conveyance problem	[Factoor4=3.5]	-2.416	0.742	10.595	1	0.001
	[Factoor4=4.5]	0[a]			0	

Based on the result of Analysis, Factor1(Physical pedestrian facility problem) and Factor2 (Traffic safety problems) are the most significant external factor which influence pedestrian not to preferred or lowered their satisfaction level of pedestrian on existing facility.

Physical walking facility problem has found to make pedestrian not satisfied on the existing pedestrian facility. Based on overview of pedestrian, pedestrians have agreed that, pedestrian facility problems are the main reason for most pedestrian which rating from most of the time to sometime reason by keeping the influence of any other variable effect as it is.

It is obvious that most of pedestrian facility in Addis Ababa City have great problem such as very narrow compared to the peak hour demand of pedestrian, most of the time, jammed during evening and morning time, pedestrian facility is occupied by street market which distract the movement of pedestrian and that makes pedestrian facility not continuous and lowered their satisfaction level. Due to such type of problem, pedestrians are forced to use vehicle lane for their movement and exposed for single vehicle crash or run-off vehicle crash. The output of the effect of this factor on this study has argued with other previous study (Asadi-Shekari, Moeinaddini, & Zaly, 2013),

(Blecˇic, Cecchini, Congiu , Fancello, & Talu, 2020), (Adkins, A.,, Dill, J., , Luhr, G., & Neal, M. , 2012), (Chung, 2012),and (J. & N., 170) even if the extent of effect is very small as compared to this research result.

Traffic safety problem is the second main problem of mode choicer of walking based on pedestrian attitudinal survey. Based on the result of analysis, the existing pedestrian facility of Addis Ababa is highly exposed for run-off vehicle or roadside vehicle crash. It makes the pedestrian not to use the facility or lower their degree of satisfaction by the facility by log odds of 3.37 times than well protected and well safer pedestrian facility. Because most pedestrian facility in Addis Ababa are not secured from road side traffic crash since there is no traffic barrier that can separated from vehicle road to pedestrian facility. On the proportion of mode choice of Addis Ababa city resident, 60 % of resident are using walking as a mode of transport (AATMA, 2019). However, in terms of facility distribution, walking facility contributed the least even; it is possible to say none comparative to vehicle road, even if the existing pedestrian facilities are not secured from road side vehicle crash. Due to this reason, 80% of fatal and serious injuries vulnerable are pedestrian (AATMA, 2019) which assured the output of this study and other study conducted in different foreign city (Hine.J, 1996), (Adkins, A.,, Dill, J., , Luhr, G., & Neal, M. , 2012) and (Oh & Seo, 2015).

Regarding to the surface of the existing pedestrian facility, it is also found to be a problem based on pedestrian perception survey. It is true because most of pedestrian road facility in Addis Ababa city is not smooth that cause sliding and falling of pedestrian rather it is undulating surface which capture water based on the observational study. Based on the result of analysis, comfort and convenience of existing pedestrian facility lowered pedestrian level of satisfaction by log odds of 2.46 times by keeping all other variable as it is.

At all, Addis Ababa city Pedestrian facility has many problems not only traffic safety problem but also the provided pedestrian facility cannot accommodate the peak hour demand of pedestrian especially on commercial and institutional area which shows that very congested pedestrian which is difficult to express in terms of density per square meter.

On categorical socio-demographic variable, pedestrians marriage status is not found significant on existing pedestrian facility as per the result of the study. This is due to crowded and congestion

of pedestrian facility, discontinuity of walking way that could too late all pedestrians' groups especially those who use it for the purpose of shopping and education tripe it is well known that, everyone use pedestrian at least for the purpose of short-term tripe. The effect of **marriage status** on pedestrian level of satisfaction found in this study have not argue with other similar studies conducted by several researchers (Evans & Norman, 1998), (E. M. Cepolina, F. Menichini, & P. Gonzalez , 2018), (Granié, 2013), (Hilland, T. A., , et al., 2020) and (Holland, & Hill, 2007), (Marquet, O., , Hipp, J. A., , & Miralles-Guasch, C. , 2017).

Based on the above aforementioned summary of literature, all are concluded that males are more frequently using walking as work tripe than females and, single teenagers but not found significant on their level of satisfaction (Marquet, O., , Hipp, J. A., , & Miralles-Guasch, C. , 2017), (Papageorgiou, G., , Balamou, E., , Efstathiadou, T., , Xergia, S., , & Maimaris, A. , 2018) and (Rišová, K., & Madajová, M. S. , 2020).In contrary to this (Lyu, Y., & Forsyth, A. , 2021) females are used walking more frequently but less satisfaction with existing pedestrian facility than male pedestrians.

Nevertheless, several studies also (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014) mentioned that have reported inconsistent results between genders. (Asadi-Shekari, Moeinaddini, & Zaly, 2013) supported those findings, stating that both men and women profess quite similar opinions on pedestrian walkways. Even so, some researchers believe that gender plays a significant role in determining the choice of transportation mode. (Rišová, K., & Madajová, M. S. , 2020) reported significant gender differences in safety perception toward walking. Women tend to feel unsafe when walking, while men are less concerned about feeling safe. Due to the issue of safety, women choose to drive rather than walk for travel purposes (Seong, E. Y., , Lee, N. H., , & Choi, C. G, 2021).However, in this study, even if both female and males are participated in pedestrian attitudinal survey, it is not found significant based on statistical output, and it may be due to both gender groups have almost similar attitude on existing pedestrian facility.

Based on the above literature review, sociodemographic factors such as marriage status, gender, age, household income level, and education level have been associated with user behavior toward the expectation and satisfaction level of the transportation mode they choice (Larouche, R., , Saunders, T. , Faulkner, G. E. J, Colley, R., , & Tremblay, M. , 2014) , (Kim, E. J., , Kim, J., , &

Kim, H. , 2020), (Williams, G. C., , Borghese, M. M., , & Janssen, I. , 2017), (González, S. A., , Aubert, S., , Barnes, J. D., , Larouche, R., , & Tremblay, M. S. , 2020) However, in this study, gender and marriage status have not found satisfactory even at 90% confidence level.

Age category group of pedestrians under age of 18 years old and between age range of 18-30 years old are found to be have better satisfaction level on existing pedestrian facility by log odds of 1.657 and 1.180 times respectively at 95% confidence level by keeping all other variable as it is. On other hand, pedestrians with age group of intermediate and above are not found significant since they are not more frequently use it as active mode of transportation. However, based on the literature review, there is no distinct result, some researcher suggested that older people use active transportation less frequently than younger people (Marquet, O., , Hipp, J. A., , & Miralles-Guasch, C. , 2017), (Papageorgiou, G., , Balamou, E., , Efstathiadou, T., , Xergia, S., , & Maimaris, A. , 2018) and (Rišová, K., & Madajová, M. S. , 2020). In contrary to this (Lyu, Y., & Forsyth, A. , 2021) reported that older people are more likely to walk.

Education category of the pedestrians are found to have the most significant and dominant factor found in this study. Pedestrians with all educational category groups are found significant at 90%confidence level which are not satisfied at all with respect to pedestrians with very advanced education level. So, based on the result of the study Education catgory1, Education catgory1, Education catgory1, are Education catgory1 reduce the pedestrian level of satisfaction by log odds of -4.292, -4.771, -4.033 and-4.546 times by keeping all other variable as it is. This is why all pedestrians who are educated are expected to have better awareness about other well standard pedestrian in other country, so they compare it with that they observed and know. This is argue with some studies as well but the method is different (Chung, 2012), (Bivina, Parida, Advani, & Parida, 2018), (E. M. Cepolina, F. Menichini, & P. Gonzalez , 2018) and (Bernhoft & Carstensen, 2008).

Pedestrians with **low-income level** have found to be use walking as mode of transport more frequently than pedestrians with better income level but not satisfied on existing pedestrian facility. The result of analysis indicates that pedestrians with better income level have satisfied with existing facility by log odds of 3.896 times by keeping all other variable constant. This is due to high income level pedestrians are not using walking most frequently rather vehicle, and they compared it with vehicle jammed during peak-off hour during this occasion of time, high level

income pedestrians preferred to use walking especially for short tripe to avoid the delay due to vehicle jam and to reduce expanse such as lubricant vehicle diesel.

However, pedestrians with low and very low-income level, are lowered their level of satisfaction by log odds of -0.997 and -1.315 times than all other high-income pedestrians who are using walking mode of transport just as raw entertainment. The output of this findings on the association of income and pedestrian satisfaction on walking transportation mode is argue with other previous findings (Jamal, S., & Mohiuddin, H. , 2020)and (Seong, E. Y., , Lee, N. H., , & Choi, C. G, 2021), which concluded that, the low-income group comprises the primary walkers, whereas the high-income group prefer driving for daily trips. This is due to a higher household income being associated with higher car ownership, discouraging walking as suggested by (Jamal, S., & Mohiuddin, H. , 2020). However, (Young, D. R., et al., 2020) noted that low-income households demonstrate a low frequency of walking transportation opportunities since related to work related opportunity.

In context of Ethiopia, particularly Addis Ababa, most of car owners have made walking trip for only recreational purpose during evening time and there is a situation of some car ownership used walking, sometimes slow running based on the description of doctor for health issue such as over weight problem. It obvious mostly in developed country which have well-organized pedestrian facility, either they used shared mobility, cycling or walking mode of transport since it is economical by keeping the duration it takes as it is.

On the other hand, (Hilland, T. A., , et al., 2020) reported no significant association between income and satisfaction of walking mode. Some studies have also concluded that, there is some association between employment status and walking transportation usage.

Pedestrians with good health condition are satisfied more times by log odds of -0.676 times than pedestrians with excellent health condition as a base point. This is unusual result by any other similar study a (Marquet, O., , Hipp, J. A., , & Miralles-Guasch, C. , 2017) and (Kim, E. J., , Kim, J., , & Kim, H. , 2020). However, pedestrians with no good health condition are not found significant independent category since they are not use it more frequently than pedestrians with good health condition.

Purpose and type of tripe is another significant variable which affect pedestrian satisfaction level at 90% confidence level. Based on the result of the study, pedestrians who are using walking mode of transport for work tripe and Education Tripe are have less satisfaction than pedestrians who are using walking mode of transport as shopping purpose by log odds of 2.882 and 0.977 times by keeping all other variable as it is. This is because shopping trip is one of the shortest types of tripe in Addis Ababa which are not worry about the quality of the facility.

As general, the pedestrian facility of Addis Ababa is below the desired and the expectation of most pedestrian not only in terms of quality but also the capacity of facility to accommodate peak hour volume of pedestrian.

4.3.3 Non-Parametric Analysis of Variance (ANOVA Test)

Analysis of variance have been conducted to identify whether the categorical independent variable has variable effect on the dependent scaled variable. In this paper, non-parametric analysis of variance has been used because the dependent variable satisfaction level of pedestrian is not normally distributed from all selected pedestrian group. The non-parametric analysis of variance has been conducted using Kruskal Wallis Test to accept or reject null hypothesis. In this case the null hypothesis for all significant categorical variable is all class of all categorical have the same effect on the level of satisfaction of pedestrian on existing facility. For more detail, the result of non- parametric analysis of variance have shown in table_17 as follows.

Table 18:Non-parametric ANOVA result

Dependent Variable	**Grouped variable**	**Ranks**		**Test Statistics**	
	Education	N	Mean Rank	Test Statistics	Level of satisfaction
Level of satisfaction	1	223	204.67	Kruskal-Wallis H	12.957
	2	112	185.99	df	3
	3	44	144.30	Asymp. Sig.	0.005
	4	4	178.50	a. Kruskal Wallis Test	
AGE		N	Mean Rank	**Test Statistics**	

Level of satisfaction	1	89	213.75	Test Statistics	Level of satisfaction
	2	214	204.37	Kruskal-Wallis H	16.877
	3	37	151.36	df	3
	4	50	157.71	Asymp. Sig.	0.001
Health condition		N	Mean Rank	Test Statistics	Level of satisfaction
Level of satisfaction	1	128	194.38	Kruskal-Wallis H	0.265
	2	159	198.65	df	2
	3	103	192.02	Asymp. Sig.	0.088
Income level		N	Mean Rank	Test statistics	Level of satisfaction
Level of satisfaction	1	100	138.17	Kruskal-Wallis H	170.759
	2	130	148.88	df	3
	3	106	306.70	Asymp. Sig.	0.000
	4	54	195.62		
Traffic safety problem		N	Mean Rank	**Test Statistics**	
Level of satisfaction	1	12	164.46	Kruskal-Wallis H	13.470
	2	342	190.25	df	2
	3	36	255.74	Asymp. Sig.	0.001
Comfort and convenience		N	Mean Rank	Teste statistics	Level of satisfaction
Level of satisfaction	2	12	140.17	Kruskal-Wallis H	11.436
	3	204	182.94	df	2
	4	174	214.04	Asymp. Sig.	0.003

Based on the result of analysis each group of education have different effect on level of satisfaction of pedestrian on existing pedestrian facility. It is already shown on the analysis result of ordinal logistic regression. It is assured based on Asymptotic significant value of p which is as function of both Kruskal-Wallis H and degree of freedom (12.957 and 3) with p value of 0.001. which implies that each group of education have different effect on level of satisfaction of pedestrian. Therefore, the null hypothesis is rejected.

In the same way, each group of age category have different effect on level of satisfaction of pedestrian on existing pedestrian facility based on ANOVA analysis. It is also shown on the analysis result of ordinal logistic regression Based on Asymptotic significant value of p which is as function of both Kruskal-Wallis H and degree of freedom (16.877and 3) that results p value of 0.000 which implies that each group of age category have different effect on level of satisfaction of pedestrian on existing pedestrian facility. Therefore, the null hypothesis is rejected. In the same way, Health condition, Income level, Traffic safety problem and Comfort and convenience, each of all this category have variable effect on the level of satisfaction of pedestrian on existing pedestrian facility. They have both value of Kruskal-Wallis H and degree of freedom (2.65, 3,170,2.759,2,13.470,3,11.436,2) respectively which have results of p value less than or equal 0.1 value. This implies that each categorical value has different effect on the level of satisfaction of pedestrian on existing facility.

4.4 Performance Evaluation of pedestrian facility level of service

For this study, Aratkilo side walk facility that run from Sides kilo square to Aratkilo square had been taken as a case study. The physical features of selected side walk had been characterized by as follows in table below.

Table 19: Physical data of walking facility

Segment	Length	Land use	Actual width	Average diameter of utility object	No. of crossing / segment	Lighting	Other walking facility
Sides kilo square to End of Lion Park (side1)	200	institutional	4	30 cm	1	Present	Absent
End of Lion Park (side) to S. Marry Church	500	commercial	4	40 cm	1	Present	Presence
S. Marry church to Aratkilo square	500	School zone	4	20 cm	0	present	Absent
Mexico LRT station to D/Work building	400	commercial	4	20 cm	0	Present	Absent

The data required for this study are traffic data of pedestrian (peak hour flow rate of pedestrian), physical characteristics of side walk facility (effective width of side walk, land use and connectivity) and other utilities provided on the side of side walk.

Traffic data of pedestrian had been taken using traffic counting survey supported by video camera. This means that the traffic data had been recorded using video camera for a duration of one hour during morning and evening time when most peak hour movement of pedestrian expected. Then after pedestrian traffic data had been extracted using VLC media player per 15-minute observation time. The physical width of side walking facility had been taken by linear method using tape where as other data (land use and connectivity, and other utilities provided on the side of side walk) had been taken by simple observation by waking along the foot path.

Table 20: Data extraction for Sides kilo square to End of Lion Park (side1)

Time	**No. of pedestrian per 15 min**	**Flow rate(pd/min)**
1:00-1:15	**640**	**43**
1:15-1:30	**572**	**38**
1:30-1:45	**542**	**36**
1:45-2:00	**627**	**42**

Table 21: Data extraction from End of Lion Park (side) to S. Marry Church

Time	No. of pedestrian per 15 min	Flow rate(pd/min)
2:00-2:15	363	24
2:15-2:30	414	28
2:30-2:45	434	29
2:45-3:00	556	37

Table 22: Data extraction from S. Marry church to Aratkilo square

Time	No. of pedestrian per 15 min	Flow rate(pd/min)
1:00-1:15	694	46
1:15-1:30	421	28
1:30-1:45	415	28
1:45-2:00	329	22

Table 23: Data extraction from Mexico LRT station to D/Work building

Time	No. of pedestrian per 15 min	Flow rate(pd/min)

11:00-11:15	**586**	**39**
11:15-11:30	**563**	**38**
11:30-11:45	**511**	**34**
11:45-12:00	**427**	**28**

4.4.1. Level of Service Analysis for each Segment

For this paper, HCM 2000 (Highway Capacity Manual, 2000) had been employed to determine the level of service of each segment using parameters of flow rate (ped/min/ft2). The provided width had been also compared and contrast with the standards such as Street design guide manual using the following checklist.

Table 24: Physical pedestrian walk way land use and other condition

Segment	Land use	Total width	Effective width= L-(D_{object} +1.5 ft)	Minimum required width Per function of landuse	No of crossing per 100 meters	Minimum number of crossings per 100 m	Availability traffic barrier	Lighting condition	Connectivity
Sides kilo									

square to End of Lion Park (side1)	Institution	4	3.24	3.7 m	Less than one	1	presence	Presence	No connectivity
End of Lion Park (side) to S. Marry Church	School	4	3.14	3.7 m	Less than one	1	absence	Presence	No connectivity
S. Marry church to Aratki	commercial	4	3.34	3.7	Less than one	1	Absence	Presence	No connectivity

lo square									
Mexico LRT station to D/Work building	commercial	4	3.34	3.7	Less than one	1	Absence	Presence	No connectivity

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Based on the safe street design manual, the minimum width of pedestrian for commercial, institutional and school zone recommends 12 ft (3.7 m) (Brownson, R. C., E. A. Baker, R. A. Housemann, L. K. Brennan, & S. J. Bacak, 1995-2003) and (Pushkarev, B., & Zupan, J, 1975). Therefore, the selected pedestrian segment of the provided actual width are 4m which is greater than the minimum width. However, the effective width of all through zone pedestrian walk way, including road segment from S. Marry church to Aratkilo square which has effective walkway width of 3.24m, which are less than the minimum required width which is 3.7 m. This is due to the presence of other utility object such as tree, electric pole, bill board and other objects which distract the movement of pedestrian which lower the pedestrian level of satisfaction and the facility level of service very much as narrow width of walk way is one of the major factor which directly affect the pedestrian mode choice and their level of satisfaction on existing facility.

Based on the safe street design Manuel, 5ft width of walkway is at least enough for two person for walking side by side. Based on the observation through video camera , the movement of pedestrian, three or four pedestrians arrived at a point on the selected roadway segment which is difficult even to Maneuver one pedestrian to other pedestrian.

On the same way connectivity is the main problems of most Addis Ababa pedestrian walkway facility which may lower the pedestrian level of satisfaction and facility level of service since on the selected road segment, all are not have a minimum side walk crossing by 100 m interval based on the safe street design manual and Rapid bus transited manual (Bak, Radoslaw & Mariusz Kiec, 2012) and (Boodlal, & Leverson, 2003). The paint of available crossing walk way is not detectable for both pedestrian and driver of vehicle since the paint is not original.

Even if, traffic barrier are provided for the purpose of delineated pedestrian walk way and vehicle lane to prevent single vehicle traffic crash with pedestrian and utility object, but, most of selected pedestrian segments except pedestrian walk way segment which run from Sides kilo square to End of Lion Park (side1), are not delineated from vehicle lane that may be the reason why most pedestrians are the most vulnerable for traffic accident based on Addis-Ababa traffic management agency annual report. Narrow pedestrian facility, connectivity, traffic safety problems were found the main factor which affect the pedestrian level of satisfaction in turn low level of service of the pedestrian facility based on the finding of specific objective 1and specific object 2.The main encouraging opportunity for the selected pedestrian walk way is lighting, all selecting sidewalk segment have lighting at night even if it has not properly provided in standard position properly and fully. Based on the observation and visually during night time, most selected pedestrian through zone selected walk way segment are occupied by street market which barrier the pedestrian

using their own path. Due to this reason, pedestrians are forced to use the vehicle lane and be exposure for traffic accident.

4.4.2. Level of service determination and Discussion

Based on this paper, the level of service of the pedestrian facility are determined based one Highway Capacity Manual (HCM-2000) (Highway Capacity Manual, 2000) using mobility criteria. The mobility criteria of pedestrian facility or walkway are determined by using the parameters of flow rate (ped/min/ft), space (ft2/ped), speed (ft/sec) and volume to capacity ratio (V/C). For this paper all parameters used to determine level of service of the pedestrian facility are employed.

Table 25: Level of service computed parameters

Walkway Segment	No.of pedestrian per 15 minute	Volume of pedestrian(ped/hr)	Capacity	Effective Width of walkway(m)	flow rate(ped/min/ft)	Average flow rate (ped//min/ft)	Space(ft2/ped)	V/C
Sides kilo square to End of Lion Park (side1)	640	2381	2560	3.24	14	14	1	0.93
	572				12			
	542				12			
	627				13			
	363	1767	2224	3.15	8	12	1	0.79

End of Lion Park (side) to S. Marry Church	414				9			
	434				10			
	556				12			
S. Marry church to Aratkilo square	694	1859	2776	3.33	14	14	1	0.67
	421				9			
	415				9			
	329				7			
Mexico LRT station to D/Work building	586	2087	2344	3.33	12	12	1	0.89
	563				12			
	511				11			
	427				9			

The level of service of walking facility have been measured by using three parameters such as flow rate(ped/min/ft), space occupied by one pedestrians(ft2/ped) and volume to capacity ratio(V/C). In this study all segments have the same level of service in all parameters such as in flow rate, space and volume to capacity ratio. The detail result of level of service of each segment with all corresponding parameters are presented as follow in the table below.

Table 26: Level of service of selected segment by deferent parameters

Walkway Segment	Average flow rate (ped//min /ft)	Level of Service(LOS) using (q)	Space(ft2/ped)	Level of Service(LOS) Using density (k)	V/C	Level of Service(LOS) Using volume to capacity ration.
Sides kilo square to End of Lion Park (side1)	14	D	1	F	0.93	E
End of Lion Park (side) to S. Marry Church	12	D	1	F	0.79	E
S. Marry church to Aratkilo square	14	D	1	F	0.67	E

Mexico LRT station to D/Work building	12	D	1	F	0.89	E

Based on the result of analysis, the level of service of all segments using parameters of pedestrian flow rate are LOS D. since based on Highway Capacity manual (HCM-2000) if the flow rate of pedestrian (ped/min/ft) is between 8 ped/min/ft and 15 ped/min/ft, so the level of service of pedestrian facility will be LOS D (Highway Capacity Manual, 2000) and (Sony Sulaksono Wibowo1 & Destri Nurhalima R. M., 2018). Therefore, based on the result of analysis, all segments such as Sides kilo square to End of Lion Park (side1), End of Lion Park (side) to S. Marry Church, S. Marry church to Aratkilo square, and Mexico LRT station to D/Work building have flow rate of 14, 12 14 and 12 ped/min/ft respectively which all are between flow rate of 8 ped/min/ft and 15 ped/min/ft. This implies based on direct HCM 2000 (Highway Capacity Manual, 2000) interpretation that freedom to select individual walking speed and to bypass other pedestrians is restricted. Crossing or reverse-flow movements face a high probability of conflict, requiring frequent changes in speed and position. The LOS provides reasonably fluid flow, but friction and interaction between pedestrians is likely.

In the same ways, the level of service of pedestrian facility using parameters of space required for one pedestrian are (ft2/ped) LOS F because the space required for one pedestrian in all selected walk way segment are 1 ft^2/ped which is less than 8 ft^2/ped. This indicates that all walking speeds are severely restricted, and forward progress is made only by shuffling. There is frequent unavoidable contact with other pedestrians. Cross-and reverse-flow movements are virtually impossible. Space is more characteristic of queued pedestrians than of moving pedestrian streams. Volume to capacity ratio have been also employed to determine level of service. Based on the volume of pedestrian and capacity of walkway facility analysis of all walkway segment that have value of 0.93, 0.79, 0.67 and 0.89 respectively with walking segment of Sides kilo square to End of Lion Park (side1), End of Lion Park (side) to S. Marry Church, S. Marry church to Aratkilo square, and Mexico LRT station to D/Work building. Therefore all values are included between 0.67 and 1 which implies that level of service (LOS E). Therefore, LOS E implies based on the interpretation of HCM 2000," 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. Cross- or reverse-flow movements are possible only with extreme difficulties. Design volumes approach the limit of walkway capacity, with stoppages and interruptions to flow".

In general, the level of service of all selected pedestrian walk way is very low as compared to the standards required by the safe street design Manuel. For instance, the provided width of pedestrian walkway is not enough to accommodate the peak hour demand of the pedestrian in terms of capacity. The provided pedestrian walk way has not traffic barrier which can prevent pedestrian from run out traffic crash or single vehicle traffic crash. The crossing walk way is not provided in maximum100 meter interval which is difficult to connecting two sidewalk which are found in

opposite direction. The paint or the visibility of provided crossing walkway is also another critical problem for all pedestrian. Due to this problem pedestrians are prefer jay walk rather than using crossing walk way. Therefore, the level of service of pedestrian facility is directly linked to the level of satisfaction of pedestrian who used walking mode of transport as tripe mode choice. Based on the result of pedestrian level of satisfaction survey on existing pedestrian facility, most pedestrians who used the selected sidewalk way segment shows no satisfaction or low satisfaction based on pedestrian attitudinal survey result. This assured that, the provided level of service of the facility has very low level of service or level of service of PLOS D, PLOS E and PLOS F in terms of mobility or capacity. In addition to, mobility, no connectivity, no-crossing walkway, safety and security issue of pedestrian walkway makes the user less or no satisfaction on existing pedestrian facility. To sum up, the urban road planner should reconsider the capacity of sidewalk facility, connectivity of sidewalk and the visibility of road marking signs to improve the level of service of the existing pedestrian facility. Whereas the traffic management agency, should consider the lighting and traffic barrier as well as the priority of pedestrian for crossing traffic lane using crossing walkway to scale up the level of satisfaction of pedestrian on using side walk.

4.4.3. Interaction of pedestrian with traffic signal, marking and signs

Based on the observation of the movement of pedestrian with pedestrian, traffic signal during crossing, traffic sign and traffic marking, they are highly influenced by those factor. Some pedestrians are crossing at the same time and place while the green phase of the signal is on and vehicle are also traveling which is very serious cause of pedestrian traffic injury and lower pedestrian level of satisfaction which may assured the level of service of selected pedestrian is either of **D, E OR F** which is the lost according to Highway capacity manual. Most drivers are yielding their vehicle when pedestrians are illegally crossing the traffic lane while green phase is

on and cause rear end collission with the behind vehicle, not only the main cause of traffic accident but also lower the capacity of traffic signal based on the observational survey. Based on the observation of selected road segment, pedestrian mid-block crossing is one of the road marking which is open for pedestrian crossing from one side to the other side. However, most pedestrian are not follow the path of pedestrian mid-block crossing rather jay-walk because the pedestrian mid-block crossing are not visible and not-intentional since the paint is not original pavement paint. By keeping the visibility and intentionality of the pedestrian, mid-block crossing, all of pedestrian crossing are not provided uniformly by maximum of 100m interval. This makes pedestrian forced to cross traffic lane other than pedestrian crossing path. Most pedestrians are also engage in various form of non-verbal communication with other road users. This include gazing, hand gesture, nodding or changing their behavior. The speed of the vehicle, the approach distance to the contact point, the structure of street and the drivers reaction can impact the pedestrian level of confidence to cross.

Road side object and activity are also another factor which distract the movement of pedestrian and forced to use traffic lane or parking lane for walking and cause road side collision with pedestrian. In downtown area of Addis Ababa, most of main pedestrian streets are occupied with street illegal market especially during evening time when peak hour pedestrian flow are observed. This makes lowered the level of service of the pedestrian facility and in turn lower level of satisfaction of pedestrian on the existing facility as it is assured on the specific objective 1 by keeping socio-demographic characteristics of pedestrian as it is.

Pedestrians have also showed great interaction with lighting of pedestrian facility. Based on the observation, the movement of pedestrian are calm-down and feel good while the light is on. On

the other hand, pedestrians are fell fear and sometimes slight running while the light is off since they expect exposition of thieves and robberies.

Pedestrians are feel discomfort when the pedestrian facilities are fully congested by pedestrian since the exposed to pull an push activity of pedestrian, side contact of pedestrian to pedestrian which is create opportunity for thieves to take off something from the pedestrians. All this things lower the pedestrian level of service functionally and decrease the pedestrian level of satisfaction which may assured the specific objective 1 of the paper.

Chapter Five: Conclusion and Recommendation

The main objective of this study is performance evaluation of pedestrian level of service and assessing the existing pedestrian walking facility so as to identify external factors influencing satisfaction level of pedestrian in addition to socio-economic and demographic characteristics of pedestrian. To achieve the overall objective of this study logistic regressions have been employed by following factor analysis of multiple external factors in addition to HCM2000 method. Videography pedestrian survey, and a total of 390 pedestrian attitudinal surveys had been taken for the analysis. The method of analysis was ordinal logistic regression analysis by following principal component analysis of multiple external factors.

- Based on the result of factor analysis (principal component analysis), four major grouped factors have been extracted such as walking facility problem, traffic safety problem, comfort and convenience issue, and security problem that have been able to explain the variance of 32.6%,21.3%,13.5% and 8.4% respectively.
- As per the result of ordinal logistic regression external factors such as walking facility problem, comfort and convenience and traffic safety problems are, claimed by most pedestrian the are the main factor which affect their level of satisfaction in different method.
- From socio-demographic characteristics of pedestrian **marriage status** and gender of pedestrians are found not significant variable at 90% confidence level. **Whereas Age category, educational category, Income level**, health condition and purpose of tripe of pedestrians are another significant variable which influence the satisfaction of pedestrian which have different perspective on these major principal components of external factors. The result of the study implies that, pedestrians who are low education class have shown less or no satisfaction on existing pedestrian facility than advanced education group and, pedestrian with low-income level have shown less satisfaction also than high income level pedestrians.
- Based on HCM 2000, level of service analysis, all selected segments have showed lowest level of service such as PLOS E, D and F which compatibly assured the attitudinal survey of pedestrian level of satisfaction which is almost no or lowest satisfaction.

- As a recommendation, Addis Ababa city road Authority, urban road planner and traffic management agency should consider and focus those major external factors such as (walkway facility problem, convenience problem) to maximize the satisfaction level of pedestrian which impacts their satisfaction level very well.
- Recommendation for further study, study should be conducted using machine learning techniques regarding to pedestrian planned behavior which simulate from their movement that able to maximize their level of satisfaction using integrated information.

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Appendix

1. የእግረኞች ማህበራዊ-ስነ-ሕዝብ ባህሪያት

1.1. ጾታ

1. ወንድ 2. ሴት

1.2. የእግረኛ ዕድሜ

1. ከ18 በታች 2. 18-30 3. 30-50 4. ከ50 በላይ

1.3. የእግረኞች የትምህርት ደረጃ

1. የመጀመሪያ ደረጃ ትምህርት 2. ሁለተኛ ደረጃ ትምህርት 3. ዲፕሎማ 4. ዲግሪ እና ከዚያ በላይ

1.4. የእግረኞች ጤና ሁኔታ

1. በጣም ጥሩ 2. ጥሩ 3. ታካሚ

1.5. የእግር ጉዞ ዓላማ

1. የስራ ጉዞ 2. የሽመታ ጉዞ 3. የትምህርት ጉዞ 4. የመዝናኛ ጉዞ 5. ሌሎች

1.6. የሥራ ሙያ

1. የግል 2. መንግሥታዊ 3. ሥራ ፈጣሪ

1.7. የገቢ ደረጃ በወር

1. ከ2000 በታች 2. 2000< x <=5000 3. 5000<x<10000 4. ከ10,000 በላይ

2. በዚህ" "በአሁኑ የእግረኛ አገልግሎት ምን ያህል ረክተዋል?

1. በጣም ረክቻለሁ 2. ረክቻለሁ 3. ዝቅተኛ እርካታ 4. አልረካም

3. ከእርስዎ የእርካታ ደረጃ ጋር የተያያዙ የሚከተሉትን ምክንያቶች እንዴት ይገነዘባሉ?

3.1. የትራፊክ መጠን በጣም ዝቅተኛ ነው.

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

3.2. የትራፊክ ፍጥነት አስተማማኝ ነው.

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

3.3. የፖሊስ ጥበቃ እና የትራፊክ መብራት አለ።

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

3.4. ከተሽከርካሪ የትራፊክ አደጋ ደህንነት ይሰማኛል።

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

3.5. ከጉዞ፣ ከመንሸራተት እና ከመውደቅ ደህንነት ይሰማኛል።

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

3.6. ከማስፈራራት ወይም አካላዊ ጥቃት ደህንነት ይሰማኛል።

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

4. በሚከተለው መልኩ ጥሩ ተንቀሳቃሽነት አለ፡-

4.1. ሰፊ የጎን የእግር ጉዞ ፣

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

4.2. የማያቋርጥ የእግር ጉዞ ፣

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

4.3. የመተጣጠፍ አለመኖር,

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

4.4. ጥሩ የጎን የእግር ጉዞ ፣

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

4.5. የአውቶቡስ መጠለያዎች መኖር ፣

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

4.6. የመንገድ ላይ እቃዎች መገኘት.

1. በጣም አልስማማም 2. አልስማማም 3. አላውቅም 4. እስማማለሁ 5. በጣም እስማማለሁ

5. ምቾት እና ምቾት (የጎን መራመድ ንፅህና እና የእገዳ አለመኖር) አለ.

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም

6. በዚህ የእግረኛ መንገድ የእግረኞች ቁጥር በጣም ትልቅ በመሆኑ ይህ የእግረኛ መንገድ እንዲጨናነቅ ተስማምተሃል።

1. በጣም እስማማለሁ 2. እስማማለሁ 3. ገለልተኛ 4. አልስማማም 5. በጣም አልስማማም