

GIS-BASED ANALYSIS OF GREENERY INTEGRATED BETTER PEDESTRIAN WAY PLANNING IN DHAKA CITY

**Submitted to the Department of Urban and Regional Planning, Bangladesh
University of Engineering and Technology in partial fulfillment of the requirement
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MASTER OF URBAN AND REGIONAL PLANNING

Submitted by

Shamima Nasrin



**DEPARTMENT OF URBAN AND REGIONAL PLANNING
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY
DHAKA-1000, BANGLADESH**

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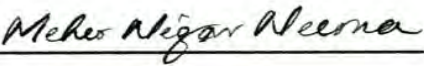
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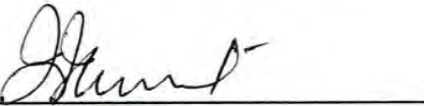
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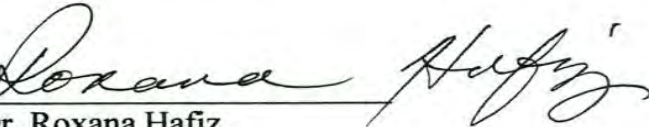
Supervisor

Dr. Meher Nigar Neema
Professor
Department of Urban and Regional Planning
BUET, Dhaka-1000.



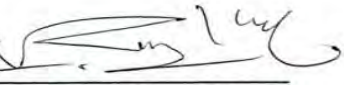
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Member (External)

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Professor
Department of Geography and Environment
Dhaka University, Dhaka.

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It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

September, 2015

Shamima Nasrin

Shamima Nasrin

This thesis is dedicated to my husband Md. Saeed Uddin Mahmud.

His continuous inspiration made this effort possible.

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ABSTRACT

Pedestrian walkway is considered as an important ingredient of environment-human system in an urban setting [1], [2]. A pleasant environment, with greenery, can make the pedestrian way more effective. Dhaka, the capital of Bangladesh is confronted with challenges encountered from several transportation problems. In this context, pedestrians are found to be the largest share of 62 percent traveler in Dhaka [3], [4]. The pedestrians require quality walking space which should be environment friendly, comfortable and attractive so that pedestrians are being encouraged to walk within the walkway [3], [4]. In addition, sidewalks designed in an integrated way with greenery can provide pedestrians to walk with a healthy feeling of fresh air.

The global trend of temperature rise, commonly known as “global warming” has been a major concern for the city planner. In such a global circumstance, cities especially those in adverse climates suffer from heat stress and are particularly vulnerable to extreme weather condition such as heat wave [5]. The most commonly adapted method for outdoor thermal comfort to provide human thermal comfort by linking local microclimatic condition with human thermal sensation is greenery [6]. The more pedestrians are on the road the safer walking is [1]. So it's very important to design the pedestrian way integrating the elements which can attract more and more pedestrians. Pedestrian streets are only successful in those areas having an aesthetical and pleasant connection with surrounding environment. Income, mode opportunities and mode use, and social factors (education, age, etc.) certainly play a strong role in frequencies of walking. But a greenery integrated, shaded, cool and comfortable and aesthetically enjoyable walk way can hinder all these factors to a large extent.

Sustainable transportation is a great challenge, at present days, for urban planners, policy makers and for service providers. With the increasing transport demand of urban population, especially in Dhaka city, it is becoming difficult to cope with problem. In such case, sustainable mobility can be achieved if urban walkway environment is provided with comfortable and barrier free walkways for the pedestrians in the city. In order to develop a pleasant and comfortable walking environment in city center, sidewalks and cross walks should be designed according to pedestrian's perception and by considering the concept of sensibility ergonomics that is defined as engineering approach to apply human sensitivity to product [7].

However, no systematic study has yet been conducted to make an effective greenery integrated GIS-based analysis of better pedestrian walkway planning in Dhaka city. Several researches have also proven that appropriate walkway design can increase both the quality and quantity of walking. If the issues related to pedestrianization are continuously overlooked, then the problems will grow to a proportion that would be hard to solve. In this research, an effort thus has been taken to provide optimal greenery integrated pedestrian walkways considering several relevant factors such as presence of greenery, pedestrian volume, design of walkways, and aesthetic condition. The research will provide such a planning framework for environment friendly walkway that the people would be encouraged to walk more than riding. This study is an attempt for emphasizing the importance of an aesthetical and thermally comfortable walkway to foster the walking in Dhaka City as well as quantifying the perception of pedestrians on walkway in a more scientific way. So that the city dwellers can depend more on foot to save their money and time as well as it will surely increase the fitness of health at the same time to walking. It will give a clear picture of the walkway environmental factors that encourage people to walk more.

Chapter 1

Chapter1

Background of the Research

1.1 Introduction

Walking is a very natural mode of transportation. Almost every outdoor trip of our day to day life starts and ends with walking. In Dhaka city, walking holds a major share of everyday total trips. For this reason, pedestrian way should be the major concern in any transportation plan and pedestrians should be considered as emancipated road users, with their special needs in comfort, time efficiency and attractive surroundings [1].

To attain sustainability in transportation sector at Dhaka city, we need to put focus on pedestrian trips rather than motorized vehicle trips. One way to increase more pedestrian trips and to attract the pedestrians to walking, improved environmental quality of pedestrian way is a precondition. In many areas of Dhaka, roads are provided with sufficient pedestrian way but those can attract a very limited quantity of pedestrians because of unpleasant and uncomfortable environment. According to Pedestrian Quality Needs (PQN) Final Report, November 2010, “people may walk, even considerably long distances, instead of driving in their air-conditioned petrol powered cars if outdoor conditions are comfortable enough for pedestrians.”

The more pedestrians are on the road the safer walking is [1]. So it's very important to design the pedestrian way integrating the elements which can attract more and more pedestrians. Pedestrian streets are only successful in those areas having an aesthetical and pleasant connection with surrounding environment. Income, mode opportunities and mode use, and social factors (education, age, etc.) certainly play a strong role in frequencies of walking. But a greenery integrated, shaded, cool and comfortable and aesthetically enjoyable walk way can hinder all these factors to a large extent.

Pedestrian way is currently an intense topic of discussion in transportation planning. While planners, policymakers, and researchers are all eagerly looking for ways to

encourage people to walk, relatively little attention has been paid to the quality of the street-level walking environment. Even though the positive effects of street greenery on thermal conditions are generally known, the physical and psychological impacts of street greenery on thermal comfort were not assessed systematically yet. The research is an intension to provide evidence to think of the needs of pedestrians more intensively.

1.2 Background and Statement of the Problem

Pedestrian walkway is considered as an important ingredient of environment-human system in an urban setting [1], [2]. A study on traditional and suburban neighborhoods of Northern California showed that changes in the built environment will cause a change in walking [7],[8]. Dhaka, the capital of Bangladesh is confronted with challenges encountered from several transportation problems. In this context, pedestrians are found to be the largest share of 62 percent traveler in Dhaka [3], [4]. The pedestrians require quality walking space which should be environment friendly, comfortable and attractive so that pedestrians are being encouraged to walk within the walkway [3], [4]. In addition, sidewalks designed in an integrated way with greenery can provide pedestrians to walk with a healthy feeling of fresh air.

A high quality green oriented environment for walking is in strong relation with aesthetic quality and design [9]. In Dhaka city, pedestrian services exist in a limited quantity and most of the cases designed without greenery. One of the worst problems in the city is insufficient walkways with inadequate supply of utilities. Nevertheless, some problems of walkways in city area discourage people to walk. It seems to be a large number of pedestrians but a limited number of pedestrian way users. It results in large portion of accidents every year [10]. In Dhaka City pedestrian accidents figure in almost half of the total accidents [11].

To experience and interact with the local environment and wider society, walking is the most effective means of transport rather than other forms of movement, especially motor transport. The Greenway is an excellent way to create more efficient mobility and manage the transportation demands of future population growth.



Fig 1.1; 1.2; 1.3; 1.4: Pedestrian way condition of Dhaka City

Source: Photograph (2014)

Greenway can provide a safe transportation alternative to cars and other transport modes. And it will make getting places easier and safer for pedestrians, bicyclists, and mass-transit users. In addition, green oriented walkway also brings health benefits to the pedestrians by giving a shaded, cool and comfortable place by mitigating heat island effect.

Some environmental factors known to influence pedestrian behavior are weather conditions, the presence of trees, the extent of lighting and the perception of safety. The greenway can bring nature back to the actual site, as well as the adjoining communities.

Simple acts like adding trees and planting a garden can enhance community pride, stewardship, and mental health as well as improve the environment. In addition, plants can help control the climate by providing shade and reducing heat, blocking the wind, reducing soil erosion, and acting as a noise barrier. But in almost all of the transportation master plan, pedestrian facilities were often overlooked or were eliminated due to a desire to control costs or to preserve a “rural look” in the community. Comfort and attractiveness of walkway are mostly ignored in roadside walking environment at Dhaka city [12].

Sustainable transportation is a great challenge, at present days, for urban planners, policy makers and for service providers. With the increasing transport demand of urban population, especially in Dhaka city, it is becoming difficult to cope with problem. In such case, sustainable mobility can be achieved if urban walkway environment is provided with comfortable and barrier free walkways for the pedestrians in the city. In order to develop a pleasant and comfortable walking environment in city center, sidewalks and cross walks should be designed according to pedestrian’s perception and by considering the concept of sensibility ergonomics that is defined as engineering approach to apply human sensitivity to product [7].

There is a strong emphasis on walking as both an indicator of and a means of improving the public realm as part of the improvement in local environment and urban renaissance (Gehl and Gemzoe, 2003). The absence of sidewalks forces pedestrians to walk in the roadway and often causes pedestrians to cross at less than desirable locations, leading to a higher pedestrian crash risk. However, the foremost negative outcome from the lack of good and continuous pedestrian facilities is inhibiting walking, which has an undesirable impact on the health of the community.

Pedestrians interact with their surrounding environments more directly than drivers in fast-moving vehicles. But, transportation researchers rarely asked pedestrians directly about their perception of the walking environment, and sometimes paid too much attention to capacity building, which may be a necessary condition but not a sufficient one for a good walking environment. While planners, policymakers, and researchers are

all eagerly looking for ways to encourage people to walk, relatively little attention has been paid to the quality of the street-level walking environment.

However, no systematic study has yet been conducted to make an effective greenery integrated GIS-based analysis of better pedestrian walkway planning in Dhaka city. Several researches have also proven that appropriate walkway design can increase both the quality and quantity of walking. If the issues related to pedestrianization are continuously overlooked, then the problems will grow to a proportion that would be hard to solve. In this research, an effort thus has been taken to provide optimal greenery integrated pedestrian walkways considering several relevant factors such as presence of greenery, pedestrian volume, design of walkways, and aesthetic condition.

1.3 Objectives of the Research

1.3.1 Specific Aims:

The main aim of present study is to focus firstly the problems and the evaluation criteria of the roadside pedestrian environment of Dhaka city. The research will also focus on the factors affecting the environment-friendly pedestrian walking.

1.3.2 Objectives:

1. To identify the flaws in the existing walkways in Dhaka city.
2. To investigate the factors of greenery integrated pedestrian way in Dhaka city.
3. To investigate the relationship between green integrated walkway and walking travel behavior in Dhaka city.

1.4 Rationale of the Study

People walk for many reasons: to go to a neighbors' house, to run errands, for school, or to get to a business meeting. People also walk for recreation and health benefits or for the enjoyment of being outside. Some pedestrians must walk to transit or other destinations if they wish to travel independently. It is a public responsibility to provide a safe, secure, and comfortable system for all people who walk. Pedestrian way environment has clearly evolved in recent days towards a more positive perception by actors involved in planning.

But still we are far away from a greenery integrated pedestrian way design culture. Our policy makers are only concerned on providing a way to walk without focusing its environmental quality especially greenery as a whole. Greenery as a part of walk way can influence on people decisions to walk to what extent- is still a question. In such circumstance, it has become important to find scientific research evidence for affects of green walk way. This research is an effort to make contribution as a new empirical foundation for future urban pedestrian way design. The purpose of this research is to help find the evidence that can be trusted and utilized by in academic fields. This research will become part of new empirical foundation for future urban pedestrian way design.

The study concentrates on the following questions:

- a) What are the obstacles faced by the pedestrians to continuous walking in Dhaka City Street?
- b) What are the factors of greenery integrated pedestrian way that can attract the pedestrians to walk within a walkway?
- c) Is there any correlation between greenery integrated pedestrian way and pedestrian volume in Dhaka city?

1.5 Possible Outcomes of the Study

In spite of a high proportion of trips made by walking in Dhaka, little has been done to improve pedestrian amenities. The research will represent a clear picture of the integrated greenery based pedestrian walking in Dhaka city. It will also reveal the factors affecting the green walking of pedestrians. In this study, a deep analysis is done on greenery factors which have direct impact on pedestrians to choose walking. The research will provide such a planning framework for environment friendly walkway that the people would be encouraged to walking. It will give a clear picture of the walkway environmental factors that encourage people to walk more. It will also investigate the correlation between greenery oriented walkway and walking from place to place. The ultimate goal of the research is to provide enough evidences that maximize the pedestrian mobility within the defined pedestrian way. The results of this model can be used to identify priority areas for the betterment and improvement in sidewalk construction and preservation as well as maintenance of the walkway in a more efficient way.

1.6 Limitations of the study

The study depends largely on secondary sources. But a very limited number of studies are available on the greenery oriented pedestrian way. Moreover those contain little information about green walkway. For that reason, developing the theoretical background was a big challenge for this research. Identifying the factors of greenery integrated pedestrian way took a long time library work and internet surfing. Data on microclimate factors (temperature, humidity etc) were collected only in summer season (from May'15 to July'15). So the research is based on data only of a certain time period rather than the whole year.

In the data collection stage, a number of obstacles had come. Among them non cooperation of respondents was a big problem. Most of them were in hurry to answer the questions of the surveyor. Those who responded, many of them gave answers without any logical explanations. Counting the pedestrians, throughout the whole day without any interval, to calculate pedestrian volume survey, was also very difficult.

1.7 Organization of the Study

The research has been conducted to evaluate the existing environmental condition of the pedestrian way in Dhaka City and to identify the factors regarding to pedestrian environment also. The study also revealed the correlation between the environmental factors of pedestrian way and pedestrian volume in Dhaka City. As the previous study on Dhaka City pedestrian way focused only on the safety and security ignoring the comfort and convenience of the walkers, the study concentrate on the most frequent travel modes' satisfaction level of the direct user, the pedestrian.

The research has been organized in eight chapters. The first chapter contains introductory discussion which includes Introduction, Background and Present Status of the Problem, Objectives and Rational of the Research, Scope, Possible outcomes and limitations of the research. The second chapter provided with literature review with the summary of various articles and thesis related to pedestrian way. These articles are somehow related to this research and gave the guidelines to build up the methodology. Chapter three contains theoretical framework to conduct the research efficiently. This chapter provides

various terms and major variables related to this study and their hypothesized relationship. In this chapter, a précised description of some developed cities' pedestrian way is given to make the study more effective. Chapter four describes the methodology of the research in detail. This chapter narrated the research instruments, reasons behind the selection of the study areas, participants for the survey, instruments used for the observation etc. This chapter also contains the techniques and methods for data analysis. Fifth chapter is provided with a detailed description and map view of the study areas previously selected for this study. Chapter six provides the evaluation of the present condition of pedestrian way in Dhaka city. Results from the observation survey conducted in the five study areas are described in this chapter on the basis of three factors (urban climate, pedestrian space and urban greenery) with sufficient photographs and field data. In chapter seven, the relationship between pedestrian volume and environmental factors related to greenery is shown through a detailed analysis of the factors. In the last chapter the results and findings of data analysis are given. The opinions of the professionals and officials of various development authorities have been incorporated in this chapter. In the last but not the least chapter contains some recommendations to set the policies in development efforts.

Chapter 2

Chapter-2

LITERATURE REVIEW & THEORETICAL FRAMEWORK

2.1 Literature Review

As stated in the introduction, most of the past pedestrian related research has been focused on pedestrian movement and pedestrian safety and security. Often, these analyses evaluate the issues of comfort and convenience experienced only by the pedestrians. Few have included analysis on greenery factors in Dhaka city. This research focuses on those issues related to green environment which manipulate the decisions of pedestrians to walk for a long distance. A study conducted on the greenery factors in Singapore stated that an environmentally comfortable walkway encourages the pedestrian to walk rather than driving [2]. It has also revealed that the temperature between shaded and non-shaded area by means of greenery is more than 3⁰C [2]. Such micro climate impacts on pedestrian way increases the volume of pedestrians in many times.

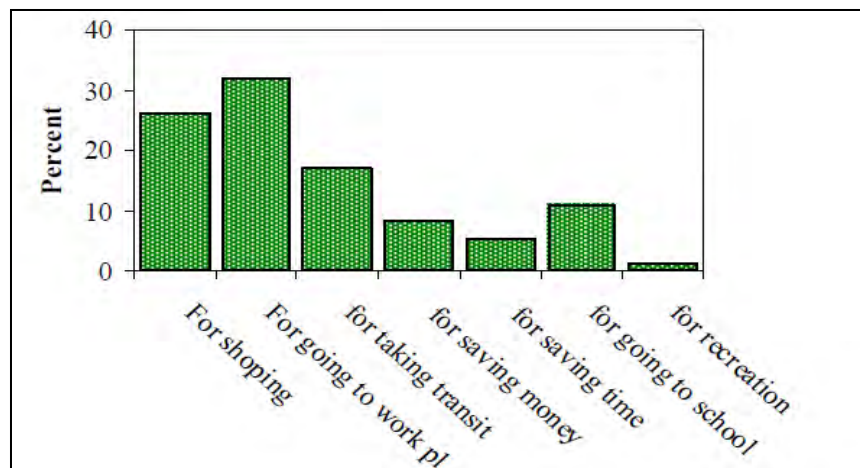


Fig 2.1: Purpose of Walking at Dhaka City

Source: Rahaman, 2005

This would create pressure on motorized vehicles and thus on overall transport network. An improved and well-designed pedestrian way can be an alternative to the motorized traffic. In such circumstance, it has been essential to find out a way that can meet the

needs of people making them eager to walk more. Not only provision of safety and security but also some environmental factors known to influence pedestrian behavior are weather conditions, the presence of shade, air flow etc. But in our roadway design, there is no provision for a specified comfortable and convenient way for pedestrians. Some researches proved that pedestrians choose the route to move according to its perception of the environment along the walkway.

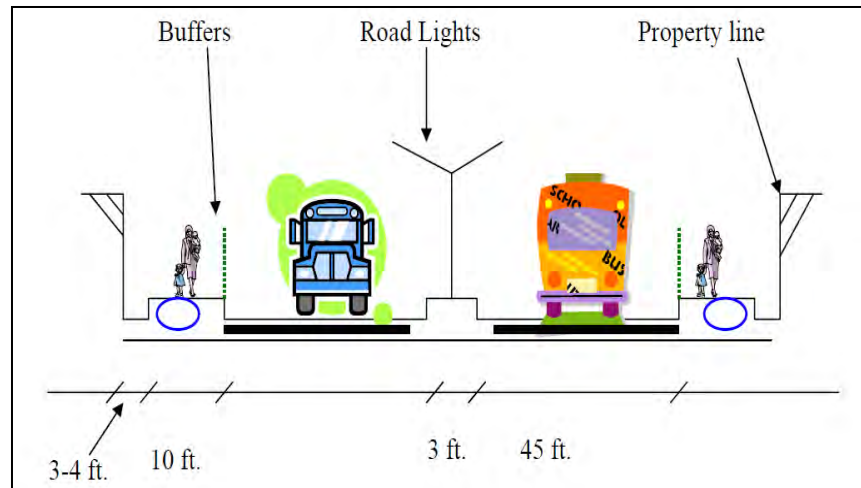


Fig 2.2: Cross section of the roads in Dhaka City as Prescribed in city road design

Source: Rahaman, 2008

Pedestrian network is a dynamic system and it develops continuously with its environment and users [13]. According to Ivan and Martin, pedestrians consider walkway as a system where physical and environmental aspects are of equal values. Only then they will start to fully use it, when this system will be build according to pedestrian needs [14]. As the walkers move fully autonomously with their personal needs and attributes in mind, so it is very important to understand the reason why places are ignored or used by pedestrians. Only then it can be properly modeled and fulfill more purposes than just a simple medium of movement.

2.1.1 Factors affecting pedestrian demand

The demand for pedestrian facilities is influenced by a number of factors of which some of the most important are,

- a) **The nature of the local community-** Walking is more likely to occur in a community that has a high proportion of young people.
- b) **Car ownership** -The availability of the private car reduces the amount of walking, even for short journey.
- c) **Local land use activities-** Walking is primarily used for short distance trips. Consequently the distance between local origins and destinations (e.g. homes and school, homes and shops) is an important factor influencing the level of demand, particularly for the young and elderly.
- d) **Quality of provision-** If good quality pedestrian facilities are provided, then demand will tend to increase.

Sustainability in transportation can be achieved if urban environment offers comfortable and barrier free walkways for the pedestrians in the city center [15]. An assessment on the impact of weather and season shows that pedestrian volume can be increased up to 20%, if the walkway can be provided with a comfortable environment to pedestrians [16]. The research also revealed that weather condition has different level of impact on male and female walkers differently. In Maryland, more than 40% of both male and female pedestrians were reported to reduce walking due to bad weather and about 12-15% stopped walking [17]. The researchers had collected data for a long time period of about one year. Weather data such as temperature, relative humidity, nature of precipitation, and wind speed etc were collected for the study. Then range, mean and standard deviation for temperature, relative humidity, precipitation and wind speed were calculated [17]. In order to evaluate the impacts of weather condition on pedestrian volume linear regression model was pursued in this research. The findings of the study suggest that season and weather have a significant effect on levels of pedestrian volume. The more pedestrians on the way the safer the walking is. So measuring the impacts of weather will allow planners and policy makers to consider weather as a factor to take steps to encourage walking [17].

In developing a pleasant and comfortable walking environment, sidewalks should be designed in accordance with the perception of pedestrians [16]. The minimum width of a designated walkway is three feet which is mentioned in ITE, Design and Safety of Pedestrian Facilities; Bicycle Federation of America (1998, p29), originated from

pedestrian level-of-service studies [18]. Konisranukul (2008) described in his research that landscape factors directly affect on walkway usage. He also stated that pedestrian would be satisfied by walkway with trees rather than walkway without tree. He concluded that landscape elements especially greenery should be the main factor for environmental design to encourage walkway usage [13]. The primary factor for appropriate walkway design should focus on the pedestrian comfort. The micro climate issues such as lack of shade, especially the walkway along the main road and heat reflected from road and other surfaces reduce the walkway usage [16]. In Panitat's research on appropriate walkway, twelve factors were identified as the reasons to use a walkway are 1) trees and shade, 2) width, 3) beauty, 4) smooth surface, 5) cleanliness, 6) convenience, 7) shade/ no heat, 8) new, 9) clear separation between sidewalk and road, 10) ventilation/ fresh air, 11) clear walkway without obstacle, and 12) short distance walking. He used a questionnaire as his major tool among the pedestrians to collect data. Panitat classified the factors to enhance the walkway usage into four categories; a) aesthetics (shade, trees, attractiveness, cleanness, new path), b) climate issue (shady, lots of trees, shade/ no heat, air flow, ventilation), c) comfort (width, smooth paving, easy to walk), and d) safety (barrier/ clear separation between road and walkway, no obstacle in walkway). Data were analyzed to test the hypothesis, assumed at the early stage of the research, using various software [12].

One of the worst problems the cities of the developing countries face is insufficient roads and inadequate supply of utilities. It is obvious to raise the problem that, when the 2-storied buildings turn to 4-storied, then the 4- storied to 8, 12 and even 22 storied, it becomes extremely difficult to achieve conducive type and quantity of roads and utilities. In Dhaka city, the transport planners are facing the same. As a solution, the authorities are finding new ways to provide new transportation network in the means of Sub way, Metro Rail etc. But these are most expensive and time consuming solutions for a developing country like ours. A well planned pedestrian network may not serve the whole purpose of a traveler but can be a major expedient of transport of daily movement. But most of our transportation related Master Plans are out of any detailed planning for pedestrian walkway which could attract people to walk rather than ride [23].

Where the major share of daily trips are made by the foot, there the pedestrian way and the preferences of pedestrians are largely ignored in transport plans. A comfortable walkway environment makes a journey by foot pleasant and enjoyable [9]. Previous studies on pedestrian problems in Dhaka city mainly focused on the safety, security, route choice etc. There is hardly any research found on the comfort and convenience of the pedestrians in the city. Measuring the impact of weather will allow planners and program managers to consider weather as a factor to increase the effectiveness of pedestrian walkway. A study in Montpelier Vermont suggests that season and weather have an effect on levels of pedestrian volume in downtown. Precipitation also reduces the average hourly volume level by approximately 13% and the winter months reduce it by 16%. At best a combination of weather variables account for 30% of the variance measured in hourly volumes [20]. For policy makers and transportation planners, these initial findings are useful in several ways. First, the consistent hourly pattern within a day and the consistency of day type (weekday/Saturday versus holiday/Sunday) suggests that correction factors and forecasting methods are feasible. The daily pattern is likely to vary significantly from place to place and an effort to define a number of pedestrian location types might assist with factor development. Second, the results indicate that weather such as cold temperature or precipitation are directly and consistently reducing aggregate levels of walking by only a moderate amount (less than 20%) [21].

Interventions for promoting walking are more effective when focused at multiple levels. Attitudes, perceptions, preferences and priorities characterize the demand side of pedestrian infrastructure since they directly affect the degree to which people travel as pedestrians. Security issues should not be underestimated, as they play a crucial role on both the tactical and the operational level. A number of researches findings in developed countries, indicate that the willingness to walk in summer is significantly influenced by the presence or the absence of shade. It was also proven that, on average, the influence of “gender” does not have a significant influence. However “age” plays a greater role on the willingness to walk for trips with the particular recreation or health destination when comparing with trips without a specific destination (also referred as abstract destination) and trips with recreation or health purpose. [17]

The priority placed on urban climate and greenery are also shared by cities including Tokyo and Singapore as revealed in the overseas review of the Study, while the undesirable pedestrian environment / public space is a particularly difficult problem in Hong Kong given its extremely high density in the Metro urban area. (Tokyo, 2005) (BD, 2005) (Singapore Green, 2003) Three key priority urban problems in Hong Kong are highlighted as below for further investigation in the Study:

- a) Undesirable air ventilation and heat island effect;
- b) Undesirable pedestrian environment / public space (especially in Metro urban area); and
- c) Lack of greenery [22].

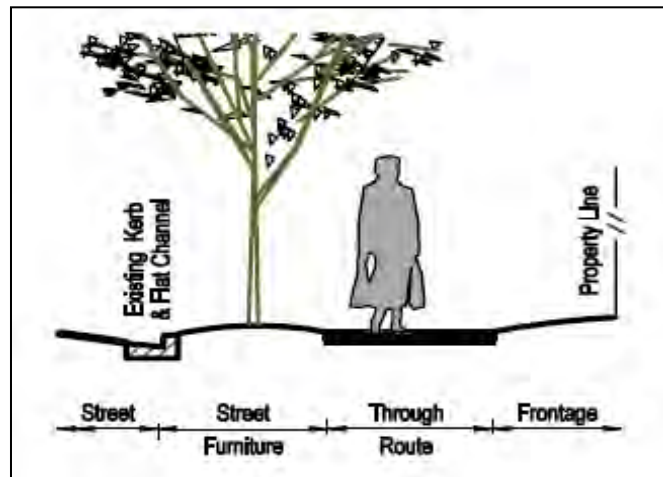


Fig 2. 3: Intersection of Pedestrian Way in Developed Countries

Source: Konisranukul, W. 2008

Pedestrian precinct generally implies a zone where pedestrians are given priority over automobiles or other motorized transportation. The precinct may incorporate wider footpaths, parking prohibition, restricted or no car access, slower speed limits-all playing a part in better pedestrian circulation [18]. Efficient pedestrian area leads people to appreciate the quality of urban environment. A lot of research works are going on to evaluate the safety and security issues of pedestrians in the road but a very limited for their comfort and convenience. Furthermore, there is a little information available for the planners to occupy them in planning the pedestrian way attractive for the users. Our master plans hardly follow the standard of pedestrian way planning. This research is an attempt to rethink the possibilities of pedestrian way to cope with the increasing

transportation needs and to reveal those facts of pedestrians which they face in their every step of walking.

2.1.2 Description of Some Developed Cities' Pedestrian Way

2.1.2.1 Kuala Lumpur, Malaysia.

Urban design addresses both the functional and aesthetic aspects of the City's built environment. Aesthetics, being the traditional concern of urban design can only be more meaningful when combined with other considerations to generate an environment that is visually pleasant, convenient, and comfortable and which conveys a sense of place, pride and belonging. Urban design activities and efforts will seek to develop a policy framework and guidelines so as to create a desirable living environment and an appropriate city image and identity. Like most cities in the developing world, Kuala Lumpur has grown at a phenomenal rate driven primarily by the need to create wealth. As Malaysia moves toward a developed status, Kuala Lumpur has experienced rapid development which has left a city that is, in many respects, disjointed and lacking in visual and physical coherence. Consequently there has been a decrease in the legibility of the city structure together with a certain loss of historical continuum and sense of identity. The ethnic and cultural composition of a city determines its character as much as, if not more than, its physical manifestations, and should therefore form urban design considerations. Kuala Lumpur's vibrant multi-ethnic and multi-cultural society will provide the stimulus to guide urban design initiatives to create a distinct and unique city identity, which will enable people to identify more closely with the City and each other, thus fostering a sense of community and social harmony.

It has developed its road network in a way that fulfills all the requirements of its users. The road system of the city has been developed in a piecemeal fashion and therefore, linkages between major and minor roads lack clarity in movement pattern. In addition, footpath widening, landscape treatment including tree planting, the provision of safer road crossings, the removal of high curb obstacles and other enhancement projects within the City Centre have been initiated to facilitate and promote pedestrianization.

Developed countries like Malaysia design their roadway system keeping in mind the prioritized way of movement called pedestrian way. These countries always focus on non-motorized way of travelling especially walking. Besides preserving the natural environment of the city, a well-designed walkway can enhance the health condition of the city dwellers and reduces dependency on motorized vehicle.

2.1.2.2 China: Pedestrian Way Planning

The cities of China pay close attention to the choice of materials it uses on new sidewalks and pedestrian streets. Instead of poured concrete or asphalt, sidewalks and other pedestrian surfaces tend to be paved with carefully laid, high-quality paving stones. The streets and landscaped areas are also edged with stone curbs. It gives the city a classy feeling and a sense that it is being built for the long term. Things may move fast in China, but that does not necessarily mean that things are done shoddily. Tree planting is not done haphazardly. Instead planting areas for trees are large and well-designed. The Chinese seem to be well-versed in the latest research on urban tree planting and landscape architecture. Trees here won't suffer from lack of space as they grow. The landscaping along the edges of streets was also impressive, and brought back memories of super-organized Singapore.



Fig 2.4: Landscape of the walkway in China
Source: Image Link [1]



Fig 2.5; 2.6; 2.7: Picture of Greenery Integrated Walkway in China

Source: Image link [2], [3], [4]

2.1.2.3 Singapore:

Singapore developed another example of pedestrian friendly city to the world. Below some examples of greenery integrated pedestrian ways in Singapore are given:



Fig 2.8; 2.9; 2.10: Greenery Integrated Pedestrian Way in Singapore

Source: Image link [5], [6], [7]

2.1.2.4 City of Cambridge: Pedestrian Plan

The pedestrian realm includes walkways and open space. Pedestrian walkways are prepared exterior routes designed to provide pedestrian accessibility. Walkways are general pedestrian routes, including plazas and courts, and sidewalks are walkways that parallel a vehicular roadway.” Plazas are outdoor spaces, open to the public, where pedestrians can pass through or gather. Often they are located at the intersection of two or more streets. Courts are indoor gathering places, often privately owned but open to the public.

The pedestrian plan has four major goals:

- To provide policies and guidelines for facilities that will make walking safer, easier, and more attractive.
- To provide design standards for physical improvements related to the pedestrian realm.
- To outline steps to encourage walking as an alternative to automobile travel, as beneficial exercise, and as a benefit to the community.
- To provide an action plan to create an economical and efficient non-automobile transportation network within Cambridge and connecting to other communities and destinations.

Given the city’s age and the variety in its physical space, the plan will best achieve its intended goals if it is applied with sensitivity to the history and idiosyncrasies of each place.

a) Driveway Curb Cuts

Driveway curb cuts allow motor vehicles to cross sidewalks - the pedestrian pathway - and should be kept to a minimum in number and width. They create the potential for conflict with pedestrians or children playing. They also present potential tripping hazards for pedestrians, especially children and elderly people [24].

b) Multiuse Paths

Cambridge has two major multiuse paths—the Paul Dudley White Bike Path along the Charles River and the Linear Park— as well as several smaller paths. The most significant addition to the existing network would be a path along the Grand Junction rail line that extends from the Charles near the BU Bridge through Cambridge port and East Cambridge and finally into Somerville. The path, if built, could connect with the multiuse Community Path that is being built through Somerville, linking with the Linear Park and the Minuteman Bikeway. Analysis and preliminary plans have been completed [24].

c) Trees

Cambridge’s many trees offer pedestrians shade and beauty, while softening the urban streetscape. They are important for cooling the streets and sidewalks in summer. Trees, however, can be a challenge for pedestrians, especially along residential streets where mature trees have encroached on narrow sidewalks, up heaving the pavement. This is especially challenging when sidewalks are reconstructed and must meet ADA/AAB’s sidewalk width standards. The City is experimenting with options such as routing the sidewalk around a tree [24].

d) Benches and Bus Shelters

Benches provide pedestrians with an opportunity to sit and rest, wait for a bus where there isn’t adequate bus shelter space, meet a friend, or read the paper [24].

e) Fences and High Walls

Some property owners construct opaque fences along the sidewalk. These are unwelcoming and detract greatly from the pedestrian realm. Instead of “eyes on the street”, the sense of safety that windows on the street provide, they offer a blank wall. Many municipalities have ordinances regulating fences along sidewalks; typically they limit the height to four feet [24].

2.2 THEORETICAL FRAMEWORK

A conceptual framework is simply the structure of the research idea or concept and how it is put together. The conceptual framework for a thesis is similar to an artist's concept illustration for a new building. It contains both narrative text such as the hypotheses and key factors, constructs or variables. The theoretical framework is also called the foundation for the parameters, or boundaries, of a study. Once these themes are established, a researcher can seek answers to the topical questions they have developed on broad subjects [17].

A conceptual framework elaborates the research problem in relation to relevant literature. This section may summarize the major (dependent and independent) variables in the research.

2.2.1 DESCRIPTION OF IMPORTANT PARAMETERS

Sidewalks accommodate pedestrians along the traveled way and they are equally important as the provision for vehicles. The sidewalk can either be placed flush with the roadside edge or next to a buffer area, such as a planted strip, located between the sidewalk and roadside. Sidewalks can also provide space for street furniture and necessary traffic poles and signals. The wider the sidewalk is, the greater the number of pedestrians that can be accommodated. Human outdoor comfort depends on a number of microclimate conditions: local wind velocity, air temperature, humidity, solar radiation, precipitation, and air quality and noise level. For a particular outdoor location to be comfortable these factors must fall within certain acceptable range. Outdoor condition differ from indoor while indoor condition can be controlled 100% according to the user, outdoor environment is less manageable with the preferences of the users.

2.2.1.1 Greenery Integrated Walkway

Human outdoor comfort depends on a number of microclimate conditions: local wind velocity, air temperature, humidity, solar radiation, precipitation, and air quality and noise level. For a particular outdoor location to be comfortable these factors must fall within certain acceptable range. Outdoor condition differ from indoor while indoor

condition can be controlled 100% according to the user, outdoor environment is less manageable with the preferences of the users.

In order to improve air ventilation, enhance the environmental quality at pedestrian level and mitigate heat island effect greenery along the walkway in Dhaka city can play a vital role. Urban ventilation has a significant impact on the temperature variations within the street as well as the surrounding environment. It has been proved that the geometry and orientation of the street canyon affect outdoor and indoor environments, solar access inside and outside the buildings, the permeability to airflow for urban ventilation, as well as the potential for cooling of the whole urban system [18].

2.2.1.2 Heat Island Effect

Heat islands occur on the surface and in the atmosphere. On a hot, sunny summer day, the sun can heat dry, exposed urban surfaces, such as roofs and pavement, to temperatures 50–90°F (27–50°C) hotter than the air, while shaded or moist surfaces—often in more rural surroundings—remain close to air temperatures [25]. The main reasons of forming UHI include heat trapping by urban geometry, properties of urban surfaces, replacement of vegetation by expansively built surfaces cover and the anthropogenic heat sources [26]- [27].

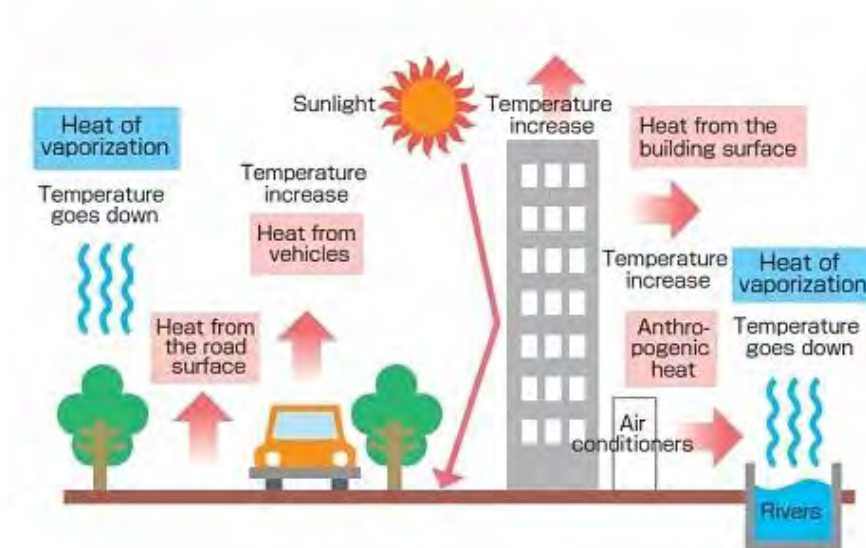


Fig 2.11: How Heat Island Occurs in City Street

Source: Voogt, J., 2002

Urban ventilation has a significant impact on the temperature variations within the street as well as the surrounding environment. It has been proved that the geometry and orientation of the street canyon affect outdoor and indoor environments, solar access inside and outside the buildings, the permeability to airflow for urban ventilation, as well as the potential for cooling of the whole urban system [29].

Rapid urbanization has caused number of negative consequences in different parts of the world. This research focuses on one of these consequences as a phenomenon known as Urban Heat Island. The UHI mitigation strategies could be categorized under three main groups:

- Cool roofs and pavements
- Green roofs
- Urban Vegetation and greenery

Urban ventilation has a significant impact on the temperature variations within the street as well as the surrounding environment. It has been proved that the geometry and orientation of the street canyon affect outdoor and indoor environments, solar access inside and outside the buildings, the permeability to airflow for urban ventilation, as well as the potential for cooling of the whole urban system [28].

2.2.1.3 Pedestrian comfort

Comfort is best defined as the absence of discomfort. People feel uncomfortable when they are too hot or too cold, or when the air is odorous and stale. Positive comfort conditions are those that do not distract by causing unpleasant sensations of temperature, drafts, humidity, or other aspects of the environment. Ideally, in a properly conditioned space, people should not be aware of equipment noise, heat, or air motion [28].

For comfort and efficiency, the human body requires a fairly narrow range of environmental conditions compared with the full scope of those found in nature. The factors that affect humans pleasantly or adversely include:

1. Temperature of the surrounding air
2. Radiant temperatures of the surrounding surfaces
3. Humidity of the air

4. Air motion
5. Odors
6. Dust
7. Aesthetics
8. Acoustics
9. Lighting

Of these, the first four relate to thermal interactions between people and their immediate environment [28].

2.2.1.4 Humidity

Humidity is simply vaporized water in the air. The percentage of water vapor in the air at a specific temperature, compared to the amount of water vapor the air is capable of holding at that temperature is most often referred to as “relative humidity.” Relative humidity that is too high or too low can be problematic to health, and comfort. For being successful, an urban space assigned to pedestrian use requires much more than mere banishing of car traffic, or giving attention to aesthetic and functional considerations. Climatic conditions at street level are also important for pedestrians and might even be decisive when considering walking as an alternative means of commuting.

2.2.1.5 Pedestrian Flow Rate

Pedestrian flow rate is the number of pedestrians passing a point per unit of time, expressed as pedestrians per 15 min or pedestrians per minute. Point refers to a line of sight across the width of a walkway perpendicular to the pedestrian path.

2.2.1.6 Pedestrian Space Requirements

Pedestrian facility designers use body depth and shoulder breadth for minimum space standards, at least implicitly. A simplified body ellipse of 0.50 m * 0.60 m, with total area of 0.30 m² is used as the basic space for a single pedestrian, as shown in Fig.3.10 this represents the practical minimum for standing pedestrians. In evaluating a pedestrian facility, an area of 0.75 m² is used as the buffer zone for each pedestrian.

A walking pedestrian requires a certain amount of forward space. This forward space is a critical dimension, since it determines the speed of the trip and the number of pedestrians

that are able to pass a point in a given time period. The forward space in the Fig 3.11 is categorized into a pacing zone and a sensory zone.

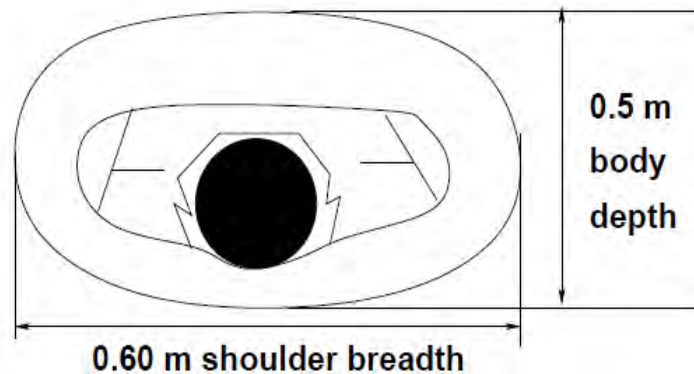


Fig 2.12: Body Eclipse for Determining the Width of Pedestrian Way Street

Source: Memon, R.A. & DYC. Leung, 2010

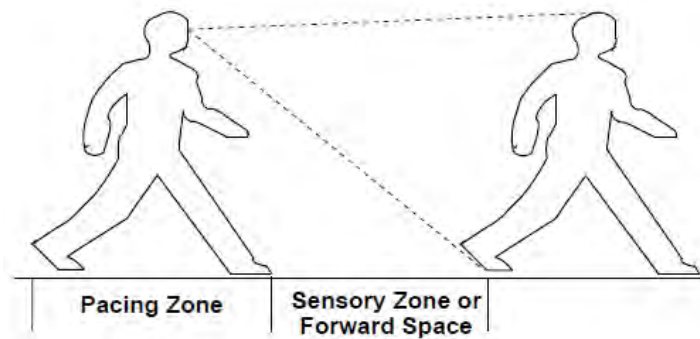


Fig 2.13: Body Eclipse for Determining the Width of Pedestrian Way Street

Source: Memon, R.A. & DYC. Leung, 2010

Sidewalks are pedestrian lanes that provide people with space to travel within the public right- of-way that is separated from roadway vehicles. They also provide places for children to walk, run, skate, ride bikes, and play. Sidewalks are associated with significant reductions in pedestrian collisions with motor vehicles.

1. Width: The minimum clear width of a pedestrian access route shall be 1220 mm exclusive of the width of curb. It varies according to pedestrian flow rate and different LOS. It is shown in following Table.

2. Cross Slope: The cross slope of the pedestrian access route shall be maximum 1:48.

3. Surfaces: Surface should be firm, stable, slip resistance and prohibit openings & avoid service elements i.e. manholes etc.

2.2.1.7 Effective width of the Facility

In designing a pedestrian facility (e.g. sidewalks), the traffic or civil engineers should pay special attention to the length and width of the facility. After the determination of basic layout, usually the length of a walking facility is determined based on the function and purpose of the facility. When the length is set, it is necessary to determine the width of the facility. The effective width of a sidewalk facility, which generally remained constant throughout the facility, should be determined to provide the comfort and convenient movements to the pedestrians.

In a flow of mass pedestrians, pedestrians are forced into an orderly pattern of movements – the flow behaves similar to that of vehicles on highway, and pedestrians often have to walk in lines of more or less straight lines [30]. Thus, the lane concept as like the highway design can be used in pedestrian flow to estimate how many pedestrians can walk abreast or pass each other simultaneously in a facility with fixed width. When two persons pass each other in a bidirectional flow on the walkway, the required lateral spacing/width for each pedestrian to avoid interference is from 0.75 m to 0.80 m [28], [29], [30]. However, this range is from 0.65 m to 0.70 m, if two pedestrians are acquainted with each other [28], [29]. In analyzing a pedestrian facility the unused space on the edges, due to the curb and walls, should be reduced from the available width. According to Navin & Wheeler [29], 1.07 m of width should be reduced from the available width to calculate the effective width of a sidewalk. Thus, the theoretical capacity of a walkway part will be greater than the actual capacity value. Furthermore, the fundamental equation for pedestrian traffic flow can be used for sizing the width of a facility [30] and are given as:

$$W = \frac{U}{k \times v}$$

Where:

W = width of the facility;

u = volume of pedestrians (peds/sec.);

v = pedestrian mean/effective speed (m/sec.) and

k = pedestrian mean density or concentration (peds/m²).

Thus, if the pedestrian effective speed is known, the width of a walking facility can be estimated. In addition, as explained in first section and the subsequent sections, the speed and/or travel time of the pedestrians can be used as a good descriptor of the LOS offered by a walkway.

2.2.1.8 Image Analysis for the Identification Proposed Greenery

Tool used:

1. Image Classification Tool
2. Image Analysis Tool

Reclassify:

- Replace values based on new information.
- Group certain values together
- Reclassify values to a common scale
- Convert cells to No Data or assign values to No Data cells.

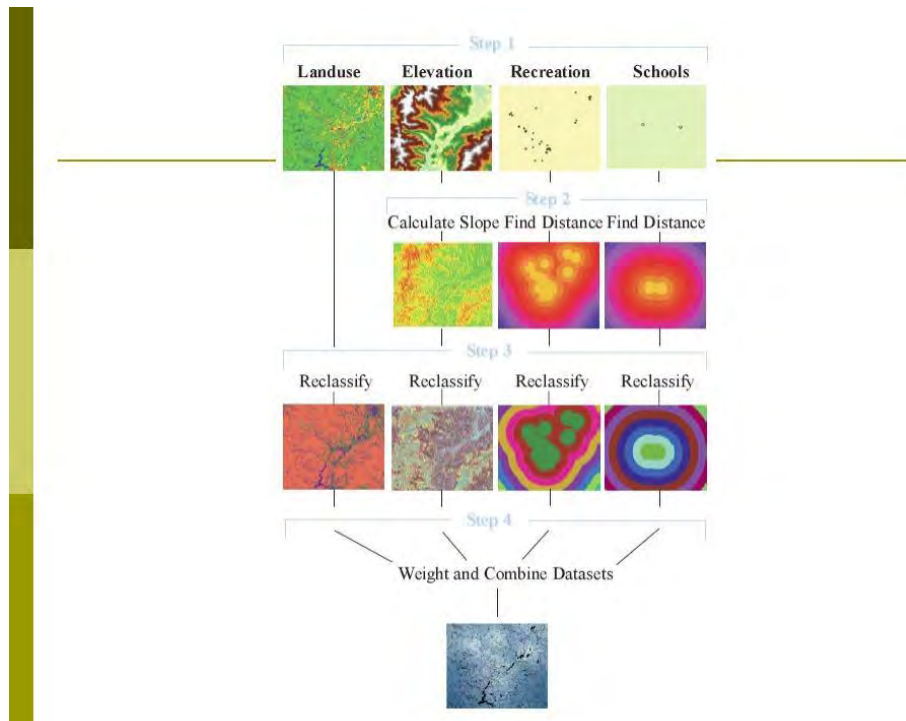


Fig 2.14: Image classification in GIC

The experience of walking means that the individual is in interaction with the environment and with other users. Obviously these interactions are related, but for the purposes of this review they will be treated as distinct and the inter-linkages will be looked at separately. The review of the literature on pedestrians has identified four sub-categories relating to the interaction with the environment: pedestrian network; pedestrian environment; infrastructure provision and its management; land use and urban form. In this study pedestrian environment in terms of greenery has been studied deeply. Various factors such as presence of shade, air temperature and humidity, air flow, people perception about greenery integrated walkway etc have been considered and analyzed to achieve the goal.

Chapter 3

CHAPTER-3

METHODOLOGY

3.1 OVERVIEW OF THE RESEARCH

The research has been conducted to determine the factors which influence the pedestrians to choose a walkway integrated with greenery and to avoid a walkway without greenery, through a study on selected areas in Dhaka city. The way to improve the quality of existing pedestrian way environment as well as the measures to increase peoples' participation is also part of the objectives.

This is a qualitative research starting from collecting secondary data i.e. Dhaka City road maps, relative literatures published in international journals, case studies and then conducting filed survey to analyze existing physical conditions and pedestrian volume at study areas by method of observation survey. After that, a questionnaire survey was conducted among pedestrians, both at greenery integrated and without greenery ways to understand people's perception about their preferences toward walkway. A pedestrian volume survey was also done in each of the study area to analyze the difference of pedestrian usage of walkway because of presence or absence of greenery. Collected data were then summarized, tabulated and analyzed to fulfill the research goals.

The research is based on a questionnaire survey and an observation survey that had been developed at the very earlier stage. Those were considered as the main data-gathering instrument for this study. The questionnaire is divided into two main sections: a profile of the respondents and the survey paper. The profile contained socio-demographic characteristics of the respondents such as age, gender, civil status, occupation etc. The survey paper has explored the perceptions of respondents, particularly on the walkway environment at present. The question paper section also contained questions to choose a particular walkway and their highest duration of walking in presence and absence of greenery.

Simple random sampling was done for the sample selection. As all walkers in an area in this method had an equal chance of becoming a research participant, this is said to

be the most efficient sampling procedure. Besides pedestrians below 15 years were being avoided to minimize unwanted and unreasonable interpretation of the questions.

The overall research was framed and conducted through the following steps:

Step 1: Selection of the Study Area:

According to Accident Research Centre (ARC) survey of BUET, there are 54 hazardous locations in Dhaka city. Five study areas are selected from these locations. All of the study areas were selected based on different characteristics on their different level of pedestrian services as follows; 1) Jatrabari, Kakrail, Moghbazar areas contain pedestrian walkways without greenery integrated walkway and 2) Manik Miya Avenue and walkways around Ramna park fall under green oriented walkway but not optimized ones.

Step 2: Data Collection:

A total number of 500 respondents were being surveyed from the five specific locations. Data on the following factors were collected through questionnaire survey and personal observation in the pedestrian walkways of the study areas:

- 1) Presence of greenery
- 2) Climate condition
- 3) Aesthetic condition
- 4) Pedestrian volume

Data on microclimate factors (temperature, humidity etc) were collected only in summer season (from May'15 to July'15). Presence of greenery was estimated from observation survey in each study areas and pointed in GIS map with the help of from Google earth map. Climate condition means data on temperature and relative humidity which were collected through automated temperature-humidity meter device. Data were collected from 8:00am to 6:00pm. Then the hourly data were been averaged on requirement. Aesthetic condition is measured based on the perception of the respondents through questionnaire survey. Pedestrian volume survey was done in five study areas on hourly basis. Then the data were divided into three time period (morning, afternoon and evening). Both questionnaire survey and pedestrian volume survey were conducted in holidays also. The questionnaire is developed as the tool of on street pedestrian survey to know the ideas and thinking toward the walkway. For observation survey various tools were used to gather the data on existing pedestrian

way. A temperature- humidity meter, measurement tape, pencil, paper etc were used to conduct the observation survey. The temperature- humidity meter was used for measuring variation of temperature and humidity at both greenery integrated pedestrian way and without green pedestrian way.

Step 3: Data Analysis

Data were collected through an observation survey, a questionnaire survey and a pedestrian volume survey conducted on the five selected study areas in Dhaka city. Collected data were encoded in GIS environment. The existing conditions of pedestrian walkways were being examined based on the considered four factors. The factors were analyzed using qualitative techniques. GIS-based analyses were performed to optimize greenery oriented pedestrian walkways by evaluating four considered factors. Image classification tool and image analysis tool were used to calculate the existing greenery of the study areas. Arc GIS 10 had been used for this analysis. Findings of this analysis present the walkways with poor conditions based on the considered four factors. Moreover, simple statistical analytical methods were used to identify relationships between greenery and pedestrians travel behavior. The analysis considered as variables demographic and personal characteristics as well as environmental conditions.

Step 4: Results and findings are presented with conclusions.

Firstly, from observation survey data to existing flaws of walkway are presented which discourage the pedestrian from use the defined walkway. Then, questionnaire survey data reveals the perception of pedestrians about the greenery along walkway. The pedestrian volume survey and observation describe the relationship between greenery factors and pedestrian volume. A common theme of any livable community is its pedestrian friendliness. This research is an attempt for emphasizing the importance of an aesthetical and thermally comfortable walkway to foster the walking in Dhaka City as well as quantifying the perception of pedestrians on walkway in a more scientific way. So that the city dwellers can depend more on foot to save their money and time as well as it will surely increase the fitness of health at the same time. The research has been conducted in three phase. In phase one theoretical framework, methodology and parameters were selected through reviewing various articles and thesis. Data collection was done in phase two. Data were collected through various

tools. Data analysis and interpretation were done in final phase. After data were analyzed, thesis was prepared and presented.

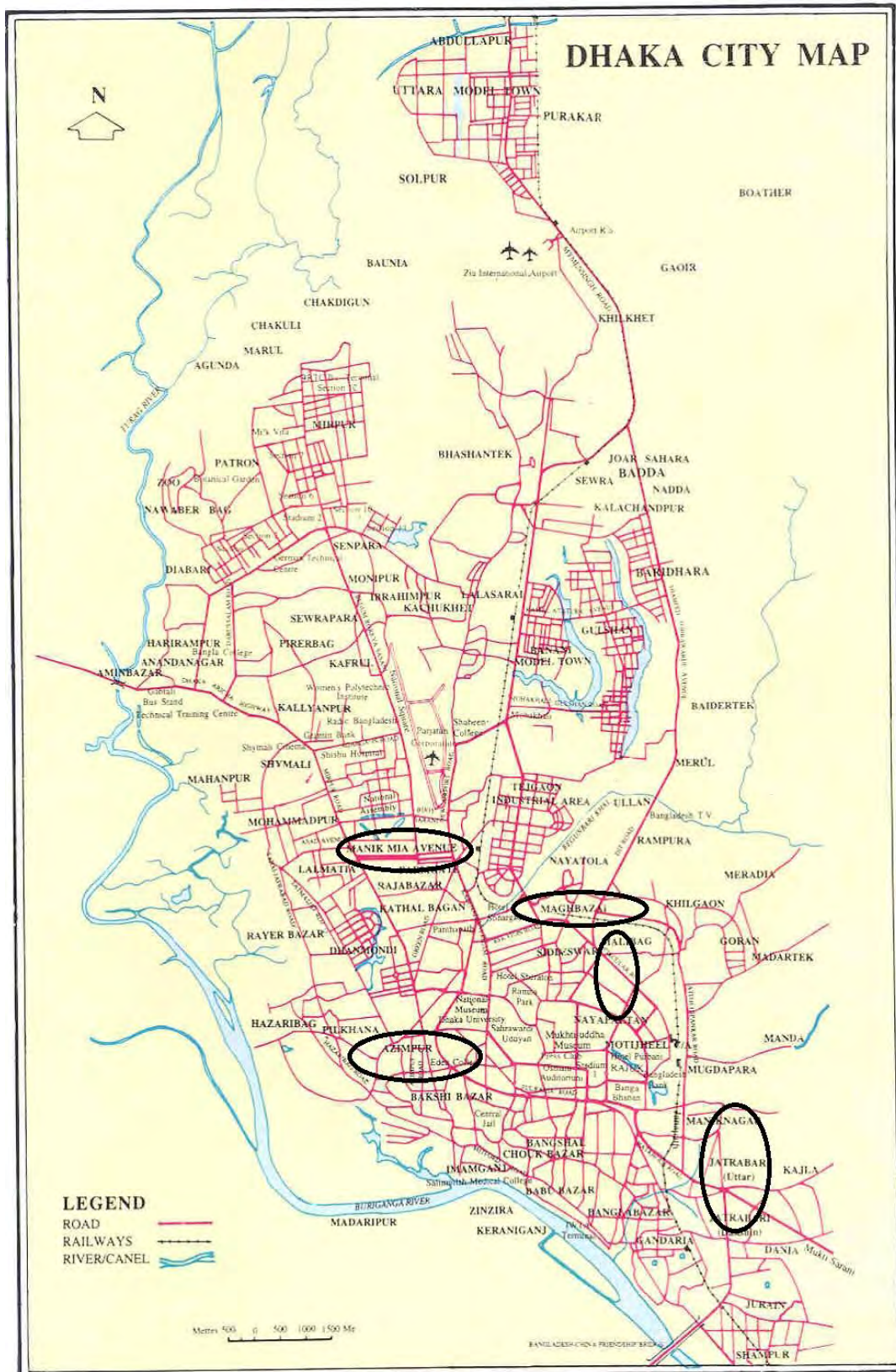


Fig 3.1: Dhaka City Road Map Showing the Study Area

Source: Image Link [2], Modified on June,2015.

Methodology is shown in the following:

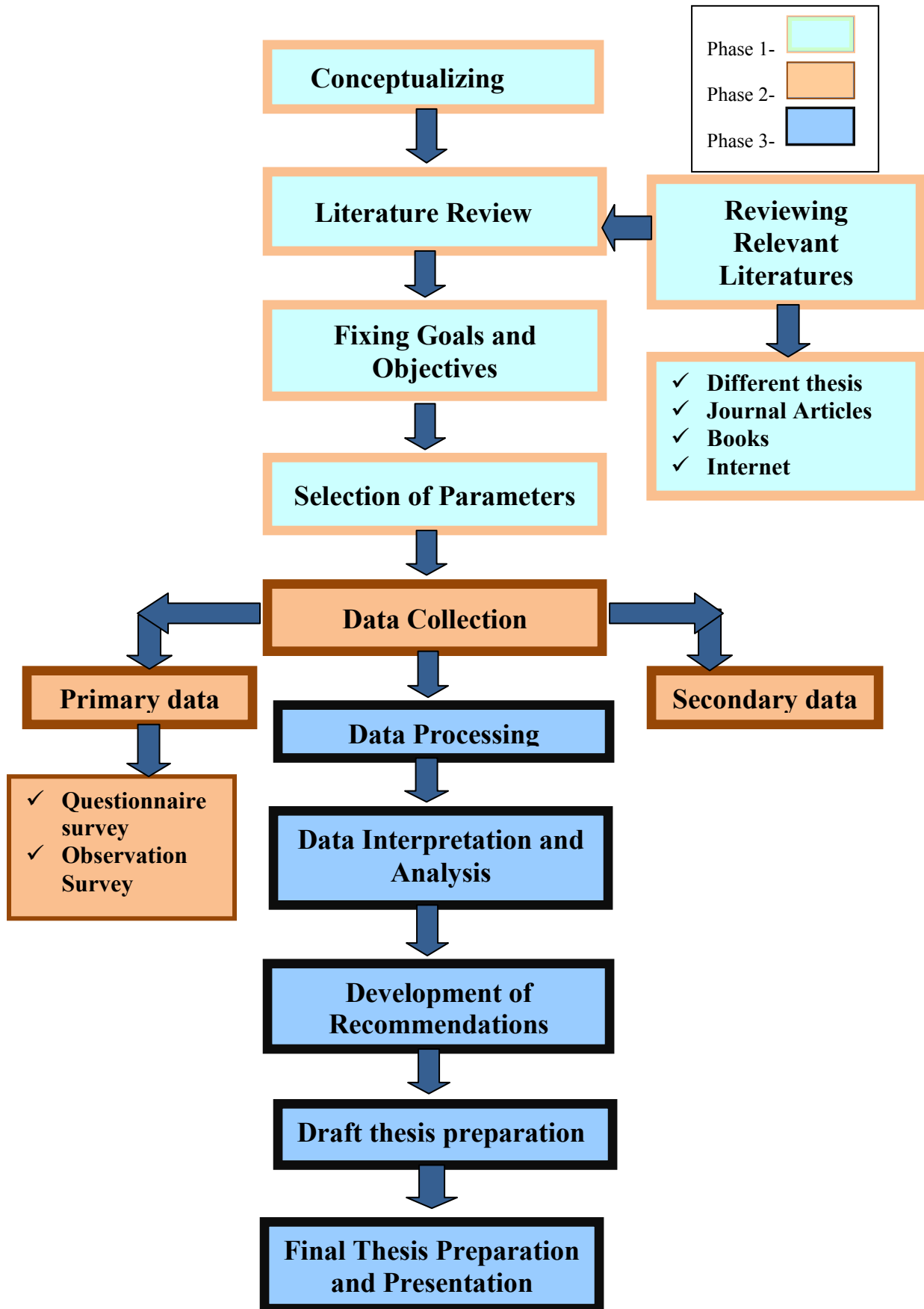


Figure 3.2: Methodology of the Research at a glance

Chapter 4

CHAPTER- 4

DESCRIPTION OF STUDY AREA

4.1 INTRODUCTION

For the research purpose five locations of Dhaka city were selected as study area. These are Jatrabari, Kakrail, Moghbazar, Manik Mia Avenue and pedestrian way along Ramna Park. The areas were selected as study areas because they fulfill the precondition of being the pedestrian way with or without the greenery. Manik Mia Avenue and Ramna Park areas are two well-known areas for their beautiful environmental condition. These roads are as comfortable as attractive for the pedestrian to walk for a long way.

Conversely, Ramna Park area is also well-known to the regular pedestrians for its well maintained, greenery integrated and comfortable walkway environment. People of different age, gender and profession use the pedestrian way daily because of its level of services and fresh, cool and comfortable walk way connected to a number of important destinations. The walkway connects many important office buildings, educational institutions and also some professional institutions. Though urbanites of Dhaka are depending highly on foot, any significant improvement of the walkways did not notice for the last decade. The selected areas for this research are highly considerable for the frequent use by the pedestrians of different age, gender and income. Most of the users are middle and low income people. So walking is a mandatory way of transportation for this type of walkers. And any modification in the walkway design will reflect a huge change in transport sector.

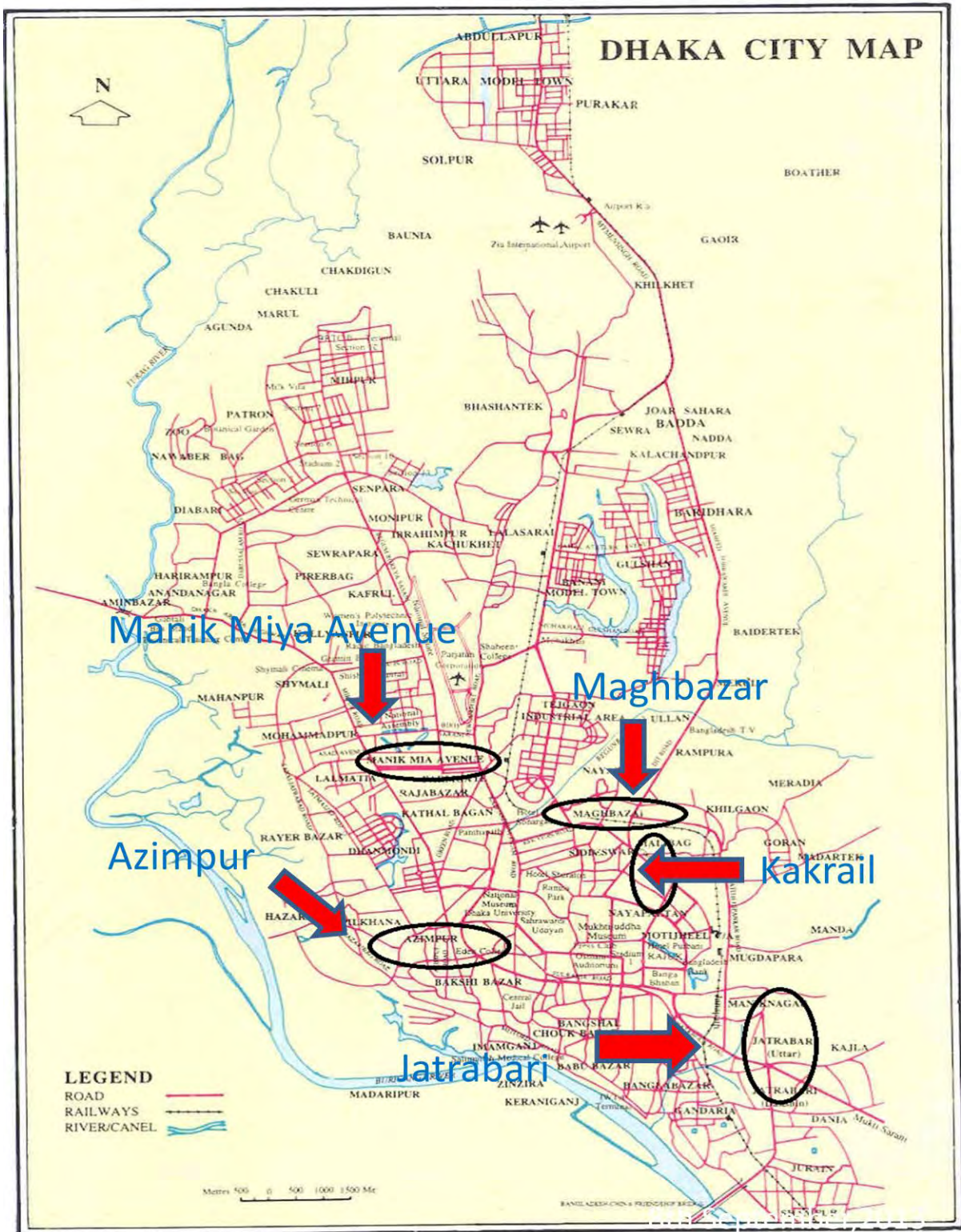


Fig 4.1: Study Area Map

Source: Image Link[2], modified on 2014

4.1.1 Manik Miya Avenue

Pedestrian way of Manik Miya Avenue is provided with all the environmental facilities like shade, cool and comfortable weather etc. At any time of the day or any season the way is used by huge number pedestrians including low, middle and high income people. The pedestrian way along Manik Miya Avenue is approximately one kilometer long. The way is so well-designed with a smooth pavement, separate lane for pedestrians, enough greenery to keep the way total shady and a natural noise barrier that makes the way a model for pedestrian way design.

For the most important landmark of the country, The Parliament House, Manik Miya Avenue is an attractive as well as well designed area in Dhaka City. Every day the walkway is passed by a huge people for different reasons including recreation, education and work purpose. Regardless the age, occupation, income level, pedestrians find the walkway aesthetically very pleasant. In any time of the day, significant number of pedestrian walks through the road.

4.1.2 Jatrabari

Jatrabari has become one of the one the busiest streets of Dhaka City. Thousands of people visit the place as it is a connection point with a number of districts. People cannot move easily as there is always huge traffic jam particularly as the street market has captured the footpath illegally. Jatrabari is a bus stop even though it is close to the famous bus station Sayedabad. It is a dangerous area for pedestrians as it's always crammed with buses, cars and taxis that seem to be in constant movement. Moreover, the rickshaws increase the traffic.

The previous name of Jatrabari was Brammonchiron when the best way of reaching this place was a water vessel. In the past, when there was no TV, cinema and electronic entertainment media, the Jatrapala (local Bangla form of drama) was very popular place for recreation. In this area there is a famous Jatramondop. Because of the wide practice of jatra culture, the place name became Jatrabari.

Jatrabari is a bus stop even though it is close to the famous bus station Sayedabad. It is a dangerous area for pedestrians as it's always crammed with buses, cars and taxis that seem to be in constant movement. Moreover, the rickshaws increase the traffic. The area is situated in the old Dhaka, where it is said old Dhaka people are not concerned about education but very serious about money making.

During the field survey, it was found that a large number of vehicles, mainly buses, trucks, human haulers, auto-rickshaws and rickshaws were unlawfully parked on roads around the Jatrabari intersection, such as the Mawa road, Chittagong road, Sylhet road, Narayanganj road and Demra road. Many vehicles were parked occupying the pedestrian way restricting smooth movement of them. Besides, many roadside shop owners had also taken over a portion of the walkway to display their products while many makeshift shops, such as tea stalls, utensil and fruit sellers, were also seen on the footpaths. Unauthorized kitchen markets on walkways and roads adjoining Jatrabari intersection are very common. Footpaths were also found to be littered with piles of rubbles and rubbish and illegal business establishments. As a result, pedestrians were left with no option but to take the muddy and over- crowded roads.

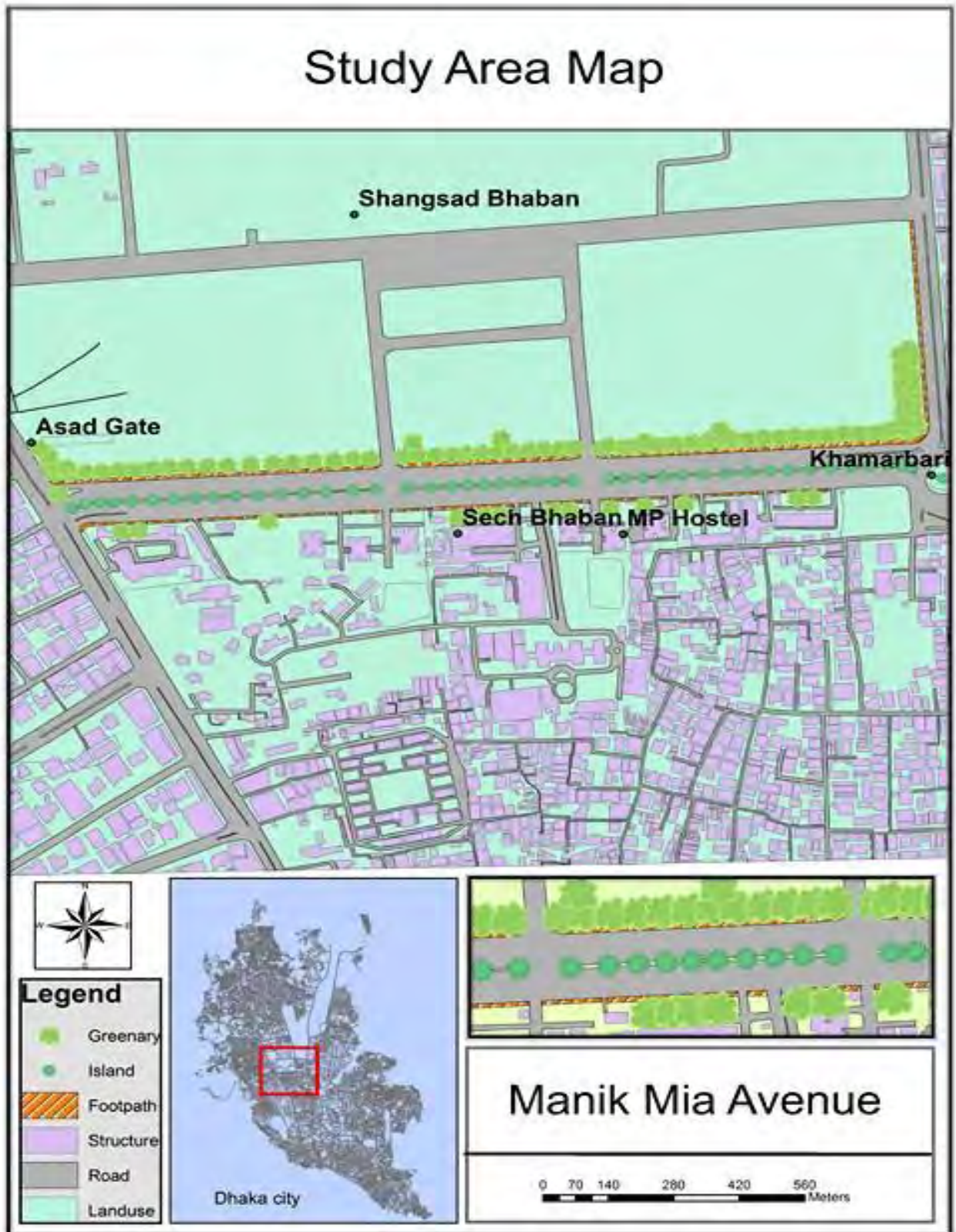


Fig 4.2: Manik Mia Avenue
 Source: GIS Map of Dhaka Road Network

Study Area Map



Fig 4.3: Study Area Map of Jatrabari

Source: GIS Map of Dhaka Road Network

4.1.3 Maghbazar

As a major commercial area of Dhaka, Maghbazar serves as one of the significant business hubs of the city. Many Governmental, educational institutions, commercial and financial institutions are located in Maghbazar. The biggest wholesale market of Dhaka, Kawran Bazar is located right beside Maghbazar.

Maghbazar is a mixed use area dominated by the residential buildings. In this area there are a significant number of institutions including banks, commercial offices, departmental stores, hotels and restaurants are significant. A number of school and colleges are also situated in this area. So the road of Maghbazar is a true busy road within Dhaka city. Recently a flyover is under construction in this area to minimize the traffic jam to a minimum level and to make the movement in this area easy and less time consuming. Hence the sufferings of the pedestrians in this area cannot be described. Maghbazar area is mainly popular for the motor parts business. The shopkeepers along the main road of Maghbazar illegally grabbed the walkway. So it is very difficult to pass the road from Maghbazar to Bangla Motor or to Mowchak or to Shaheed Tajuddin Sarani, even to kakrail on foot. People often spend a long time sitting in bus or rickshaw to go to a short one kilometer distance, when it takes only ten to fifteen minutes to walk one kilometer road.

As a transportation hub of Dhaka, the area is most often remains crowded and thousands of cars, rickshaws, minibus, bus, trucks remain stranded for even hours in the roads and streets of Maghbazar. Majority of the inhabitants of Maghbazar are servicemen and businessman. An important part of every town is its transport system and particularly its road system for affecting smooth and efficient movement of people and commodities. But the encroached sidewalks strewn with nuisances such as littered debris, garbage, overflowing dumpsters, workshop equipment and construction material along with missing or damaged slabs, open manholes, overpowering smell of urine and human faeces make taxpayers wonder if they have earned any right to walk freely on the streets at all.

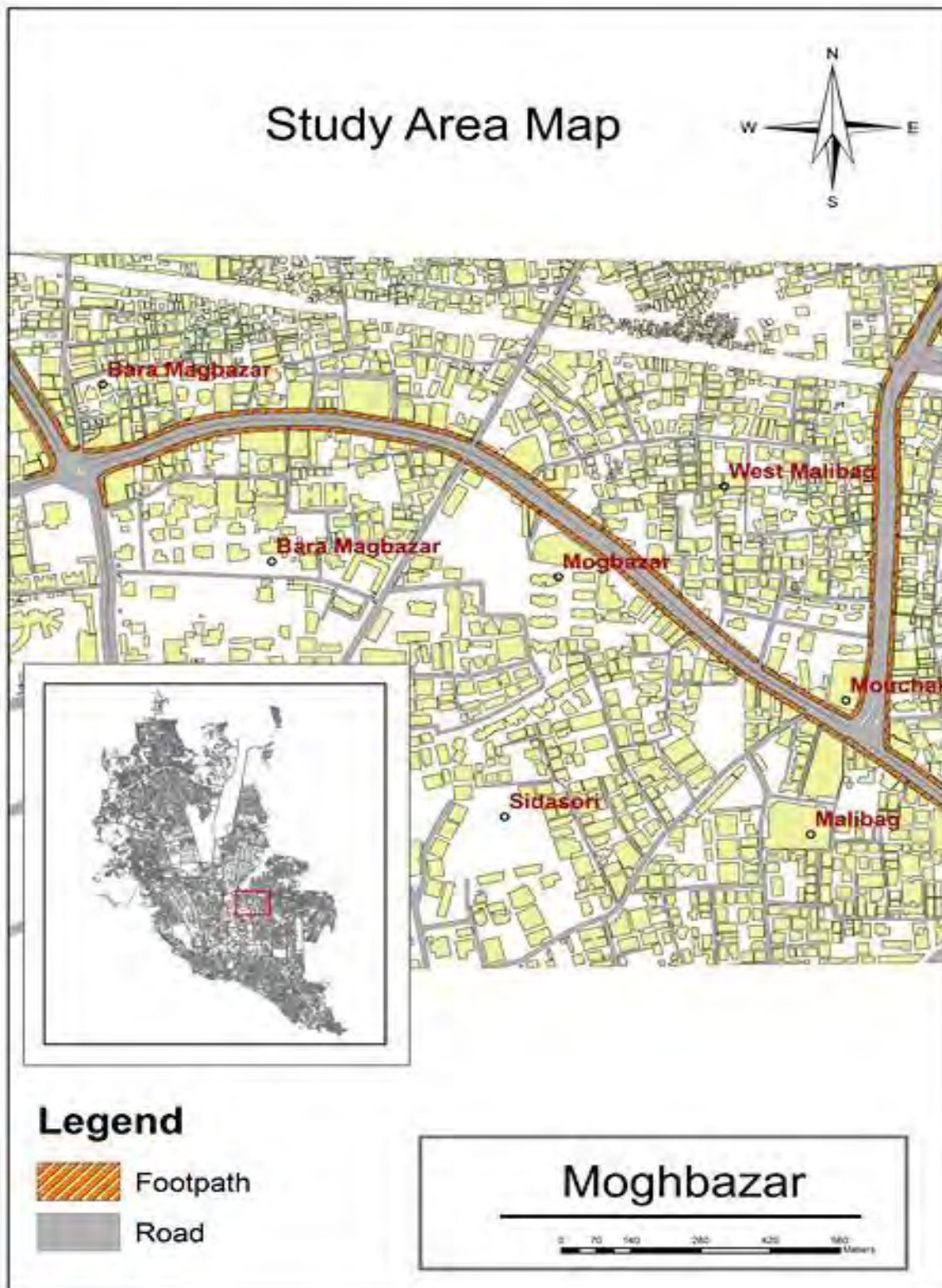


Fig 4.4: Study Area Map of Maghbazar

Source: GIS Map of Dhaka Road Network

4.1.4 Kakrail

The unplanned and neglected pedestrian way is a threat for this area. The unplanned growth of buildings are encroaching the existing green around the area, making it lifeless. The weak structure of the foot over-bridge is a threat to the lives of the large number of people using it. Many lives have been lost in road-crossing in the area. Pedestrians are facing inconveniences in walking down pedestrian way in the walkway of Kakrail and also footbridge is very uncomfortable and remained occupied by the hawkers. This situation forces the city-dwellers into jaywalking busy roads, which often causes casualties even early loss of life in grim tragedies. Sidewalks are also found occupied by the developers with brick, sand, pipes and rods stored there. This is also causing the shrinking of the space for walking.

Informal land use Pattern plays quite a vital role concerning in the sustainability of this site. Informal business through Hawkers and Vendors thrive in the pedestrian footpath of this area due to the immense pedestrian coming and going on the roads. During pedestrian survey, many of the respondents said that, this sector needs to be properly addressed and designedly allocated along the future pedestrian main stream way. Pedestrian ways are in dilapidated condition in this area. Respondents also pointed out that, better footpath means a better economy, less fossil fuel consumption and less respiratory problems caused by air pollution. Being unable to walk two or three kilometers due to environmental condition and unaesthetic condition of kakrail area, people are forced to drive to their works and combustion of fossil fuels continues to pollute air.

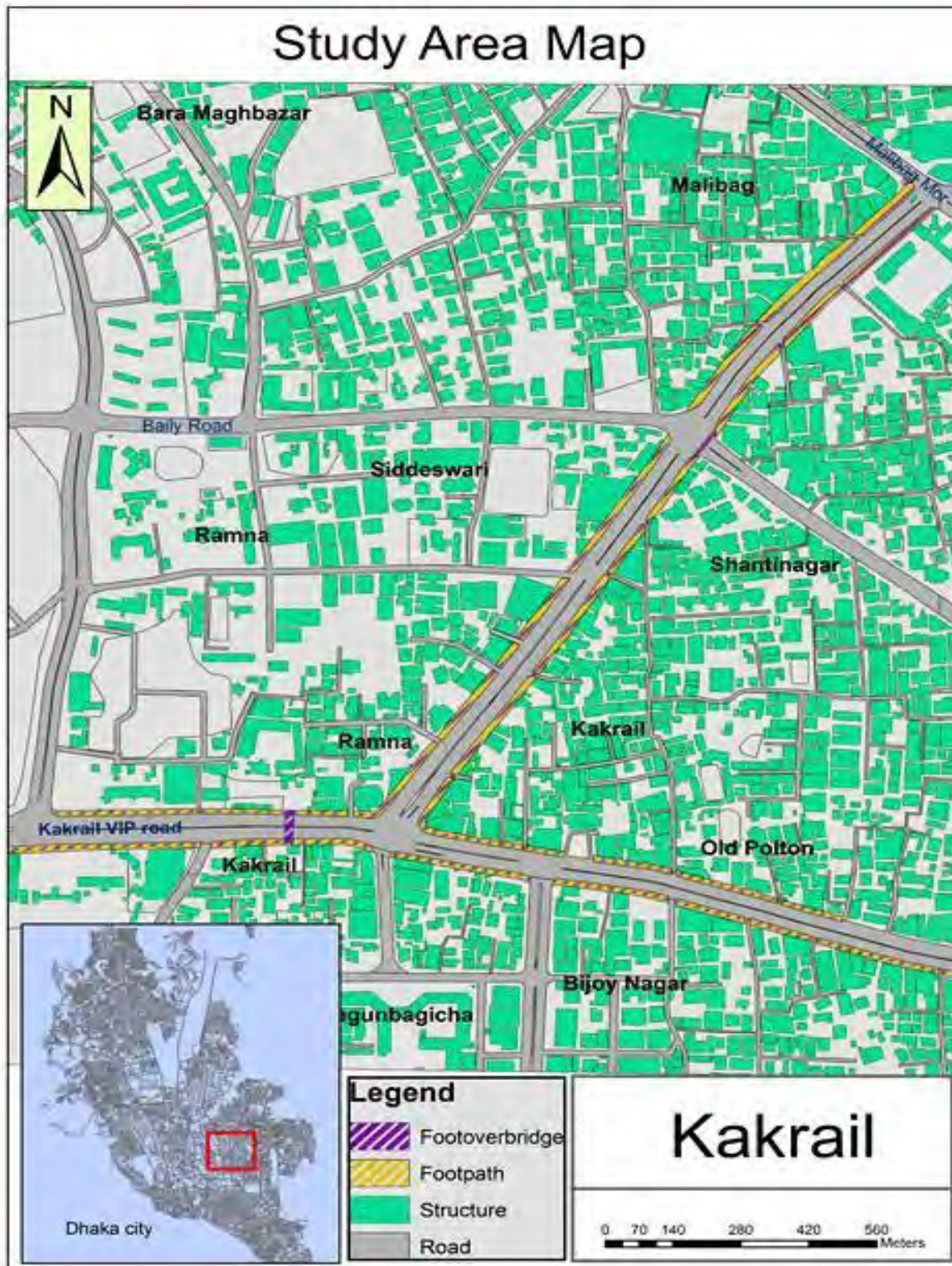


Fig 4.5: Study Area Map of Maghbazar
 Source: GIS Map of Dhaka Road Network

4.1.5 Ramna Park Area

Ramna Park is a large park and recreation area situated at the heart of Dhaka, the capital city of Bangladesh. This park is one of the most beautiful areas in Dhaka with lots of trees and a lake near its center. Ramna area began to regain its glory since 1825, when Mr. Dowes, a British collector of Dhaka initiated a series of steps for development of the city. Engaging convicts, he cleared up the bushes and demolished most tombs and monuments except the Ramna Kali Mandir. The old mosque and tomb that now stand by the western side of old High Court building were spared. The renovated area was given the name of Ramna Green and was fenced by a boundary for using it as a race course. In 1908 he began the work of a garden that took 20 years to take a shape.

The Nawabs of Dhaka developed the racecourse area as a beautiful garden and named a part of it as Shahbagh, the royal garden. The Nawabs also set up a zoo at Ramna. In 1851, the European civil servants established the Dhaka Club on the northern corner of the racecourse and after the Partition a good number of beautiful residential houses were built at Minto road area for the High Court judges and top bureaucrats.

Besides, many parents come enjoy take with their children, many lovers come enjoy their love. The walkway around the park is very well organized and pleasant to the pedestrian of all age. Ramna Park area is a place of interest to both the nature lover and the health conscious people since there are thousands of lofty trees providing fresh oxygen and wide stone-laid walkways for having some exercise in the pure air. Several built-in fitness logistics, positioned suitably in few places in the park, are very much helpful to the people eager to keep them in shape.

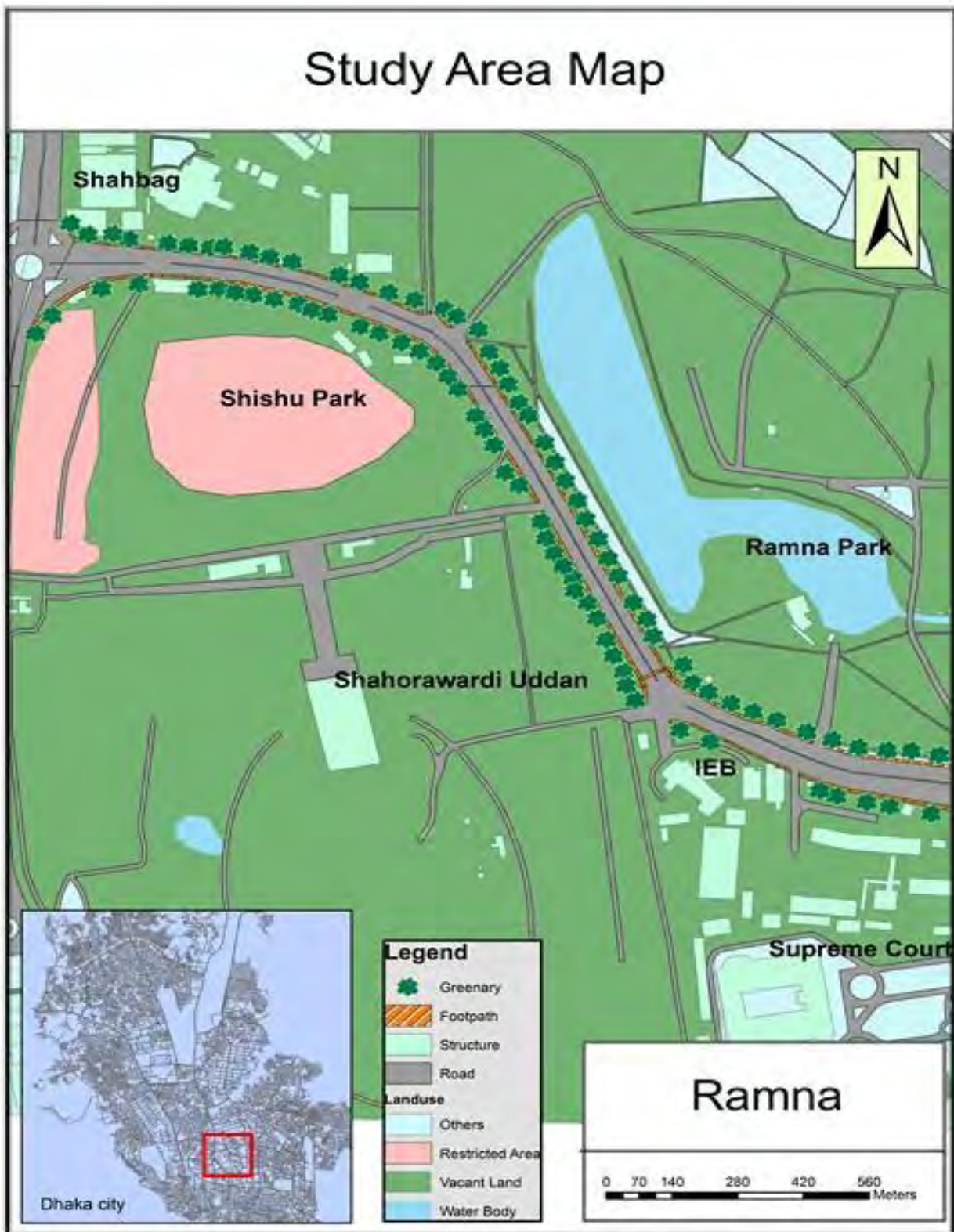


Fig 4.6: Study Area Map of Ramna Park Area
 Source: GIS Map of Dhaka Road Network

4.2 Reasons behind Choosing Study Area

Five busiest areas of Dhaka city were selected as study areas for the study. These are Kakrail, Maghbazar, Manik Miya Avenue, Jatrabari and Ramna Park Area. As the study is on the pedestrian way of the city, these five areas can be the appropriate as study area to find out the actual drawbacks and lacking of pedestrian ways in Dhaka. Firstly Kakrail is an important area as the location of some government offices and organizational head quarters. Kakrail area is also well known for Kakrail mosque. Maghbazar is a commercial cum residential area. Educational institutions, banks, government agencies, hospitals, financial institutions and residential establishments made Maghbazar is one of the crowded areas in Dhaka city. Jatrabari is the corridor of Dhaka city to enter from southern and eastern part the country. A lot of bus stoppages, kitchen markets, shops, educational institutions, shopping malls, residential buildings make the area a very busy area from dawn to dusk. Thousands of pedestrians generate everyday in this area for various purposes. So to evaluate the pedestrian way condition it is the place.

On the other hand Manik Mia Avenue and the road around Ramna Park were selected as the roads are well designed and ideal walkway to the pedestrians. The walkers find these two roads as cool, comfortable and aesthetically pleasant in all the way. The volume of pedestrians is almost consistent through the whole year. In the summer season pedestrian volume in these areas is higher than the above mentioned three areas. To make a comparison between greenery integrated pedestrian way and pedestrian way without greenery these five areas were selected according to the expert opinion as study areas.

Chapter 5

Chapter- 5

Evaluation of Present Status of Pedestrian Way of Study Area

5.1 Introduction

Dhaka is a city with various functions of administrative, commercial, industrial, educational and cultural centers. It is the commercial heart of Bangladesh. The city has historically attracted a large number of migrant workers, hawkers, peddlers, small shops, rickshaw transport, roadside vendors and stalls. In these trades the city employs a large segment of the travelers' every day as pedestrian. Though urbanites of Dhaka are depending highly on foot, any significant improvement of the walkways did not notice for the last decade. According to a 2011 study by Work for Better Bangladesh (WBB), 44% of Dhaka's roads don't even have footpaths. And 82% of the existing footpaths are in a deplorable state. The government has given "priority to pedestrians" in the national integrated multimodal transport policy of 2013. The policy has directed that clearing of footpaths; construction of wide footpaths and pedestrian-friendly roads; ensuring maintenance and cleaning; slopes on footpaths for the people with special needs; protection for pedestrians to safely cross the streets; and, giving priority to pedestrians in the traffic signal light changes.

For the purpose of human habitation a city must be topmost in terms of skill, effective from economic point of view and visually attractive and beautiful [40]. Although, a huge amount of the trips made in the city consists of walking trips, it is unfortunate that pedestrians in Dhaka has to go through unfriendly walking conditions due to the poor and unsafe walking conditions. Some of the reasons that is causing the poor walking conditions include - lack of continuous sidewalks, poorly maintained sidewalk, unclean condition, obstructions in the sidewalk due to illegal occupancy on the sidewalk (shops,

vendors, car parking), air pollution, unsafe walking conditions especially at intersections, lack of pedestrian signals at crosswalks, lack of foot over bridges or underpasses at many of the major intersections, hijackers and muggers. The poor walking conditions on the sidewalks are sometimes forcing the pedestrians to walk on the road which is increasing their chance of being involved in crashes with vehicles. Precious life is being lost in the city due to the poor conditions that prevails in the sidewalk. Such accidents are not desirable because not only does it cause loss of life and limbs but it also has a negative impact in the economy.

In this chapter, various demographic information and present status of walkway in study areas are described on the basis of observation survey. As shown in the proposed definition, the identified key generic urban living space concerns include the following three broad aspects:

- (a) **Urban Climate** - Urban climate issues with priority placed upon enhancing air ventilation and mitigating heat island effect.
- (b) **Pedestrian / Public Space** - Quality and comfort in surrounding public spaces and pedestrian areas that are conducive to a sense of place, accessibility and vitality.
- (c) **Urban Greenery** - Provision of more natural / green space for pedestrian and neighborhood benefit and enjoyment.

Traditional city forms offered people-friendly design that provided a healthy lifestyle through dense and mixed use neighborhoods, adequate amount of public space (parks, public squares plazas) and pedestrian-friendly streets. To increase mobility and to promote road safety, planners and engineers decided to separate pedestrians from roadways and design high-speed roadways.

5.2 Present Status of Walkway in Dhaka City

Increased demand for walking as a mode of transport requires sustainable planning interventions. Walking as a mode of transport assist in solving traffic congestions where by short distance within the city can be done by walking. Walking contributes to reducing air pollution, fuel consumption and effects on environment. Walking is the fastest means of moving around and enables the walker to access areas which cannot be accessed by motor vehicles. Unfortunately, this mode of transport is not prioritized in transport planning especially in developing countries irrespective of the fact that it requires inexpensive measures to invest in as compared to other modes of transport.

Footpaths are made so that pedestrians can have a safe and hassle-free walk, but almost all the footpaths alongside the major thoroughfares in the two city corporations of the capital remain illegally occupied by hawkers and others despite drives by the authorities concerned. Due to the construction works of flyover the roads in Jatrabari area and its surrounding areas have been in the worst condition for a long time. There are numerous potholes on the roads due to the construction works of the flyover causing huge traffic jam in the area. A traveler may take almost two hours to reach Jatrabari from Motijhhel via Saydabad and more due to the dilapidated condition of the road.



Fig 5.1 & 5.2: Condition of walkway in Jatrabari

Source: Image link [8], [9]

Thousands of illegal makeshift shops have sprung up, especially in Jatrabari, Maghbazar and Kakrail and some other areas of the Dhaka city. So pedestrians are forced to walk in

the carriageway risking their lives. It is strange that footpaths in a highly urbanized city like Dhaka are hardly fit to walk. As the construction of the integrated Moghbazar-Mouchak Flyover now faces further delay due to the unplanned installation of underground utility lines in the area, the procrastination in the project has been adding to the woes of locals who commute regularly through the area. Since the beginning of construction, roads along the project site had formed deep potholes and turn muddy even after a little rainfall. Vehicles, including paddled rickshaws, repeatedly get stuck or topples in these potholes, causing accidents and injuring commuters and pedestrians.



Fig 5.3 & 5.4: Condition of walkway in Maghbazar

Source: Image link [10], [11]

In Kakrail, the walkway condition is almost same as Jatrabari and Mowcak. Pedestrian ways are occupied by hawkers, tea stalls, street beggars and street residents. People especially school goers often walk through the main road as the pedestrian way is not in condition to walk. Following some common problems faced by the pedestrians is given below;

1. Very narrow walkway and in a very worst condition to walk. In some places they are broken so badly for a long time.
2. In most of the areas in Dhaka city, walkways are occupied either by the hawkers or construction materials or dustbins. These make the pedestrian way totally unable to use. Most of the Footpaths in commercial areas are encroached by them.

3. Vendors spread their treads on the footpath and eventually reduce the effective width of footpath. For that pedestrians are forced to walk along the road rather than the footpath creating serious safety hazards.



Fig 5.5 & 5.6: Pedestrian way condition in Dhaka city.

Source:

4. There are a lot of big size dustbins on the streets close to the footpath in many areas of the Dhaka city. These dustbins cause problems to pedestrians when the garbage stored inside these overflow on the streets and footpaths. At many areas of the city, people use the footpaths for toilet purpose creating problems in walking. This problem eventually forces the pedestrians to move on the roads rather than on the footpaths. But no regulatory measure is seen at all.
5. Other reasons of reduction of effective width of footpath are found as building materials on road and footpath, rickshaw stands, rent-a-car service parking, garages etc. Encroachment of footpath by building materials is a common picture in almost all over the city.
6. Another severe problem exists in the city for the people seeking a living on the footpath. This number is increasing rapidly day by day. But a few regulatory measures are taken by the police force which is very much inadequate.
7. Most pedestrian ways are poorly connected with different facilities and services (hospital, school, offices, administrative units etc.)
8. Most of the walkways are aesthetically unpleasant, unsecured and uncomfortable for physically disabled and aged persons.

5.3 Evaluation of Environmental Factors of Pedestrian Ways' in Study Areas

5.3.1 Temperature in Study Areas

Street greenery has the ability to effectively reduce urban heat and improve thermal comfort on various scale levels. Greenery in urban streets, such as trees, ameliorates thermal conditions for pedestrians. It has been proved in the research that heat in urban streets has impact on pedestrians, but also indirectly on indoor thermal comfort. In streets with large tree crowns on both sides, as Manik Miya Avenue and Ramna Park area, the temperature had been captured 2⁰C lower than in streets without greenery as in Kakrail, Maghbazar and Jatrabari areas.

Table 5.1: Average Temperature Captured in Manik Miya Avenue and Ramna Park area.

Greenery Integrated Walkway	
Time of the day	Temperature (average)
8:00 am-9:00 am	30.09° C
9:00 am-10:00 am	30.88° C
10:00 am- 11:00 am	31.34° C
11:00 am-12:00 am	33.18° C
12:00 pm-1:00 pm	33.27° C
1:00 pm-2:00 pm	34.02° C
2:00 pm-3:00 pm	34.15° C
3:00 pm-4:00 pm	33.59° C
4:00 pm-5:00 pm	33.26° C
5:00 pm- 6:00 pm	32.48° C

Source: Field Survey, 2014

Timewise Average Temperature of Manik Miya Avenue

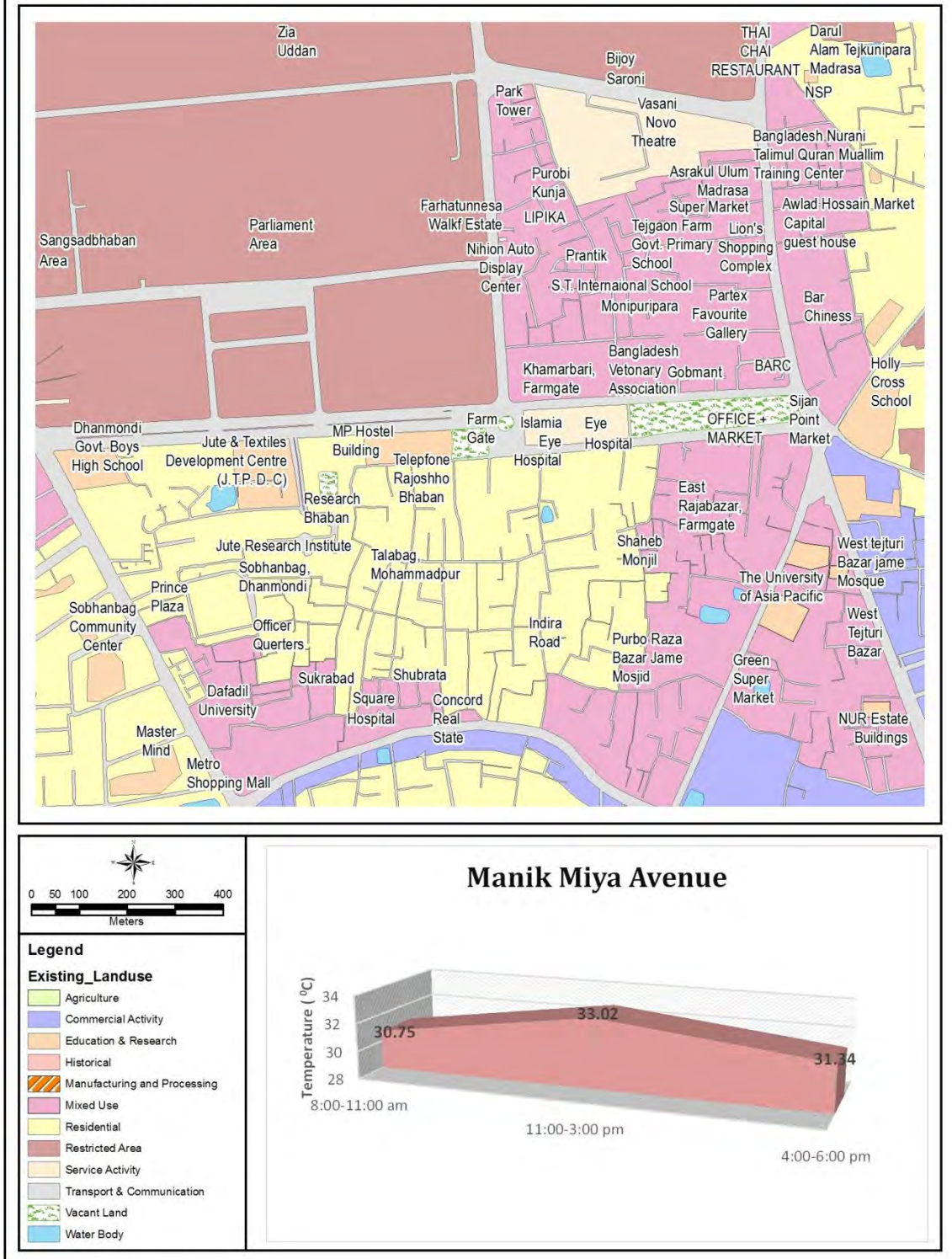


Fig 5.3: Average Temperature at different time of the day at Manik Miya Avenue

Source: Field Survey' 14

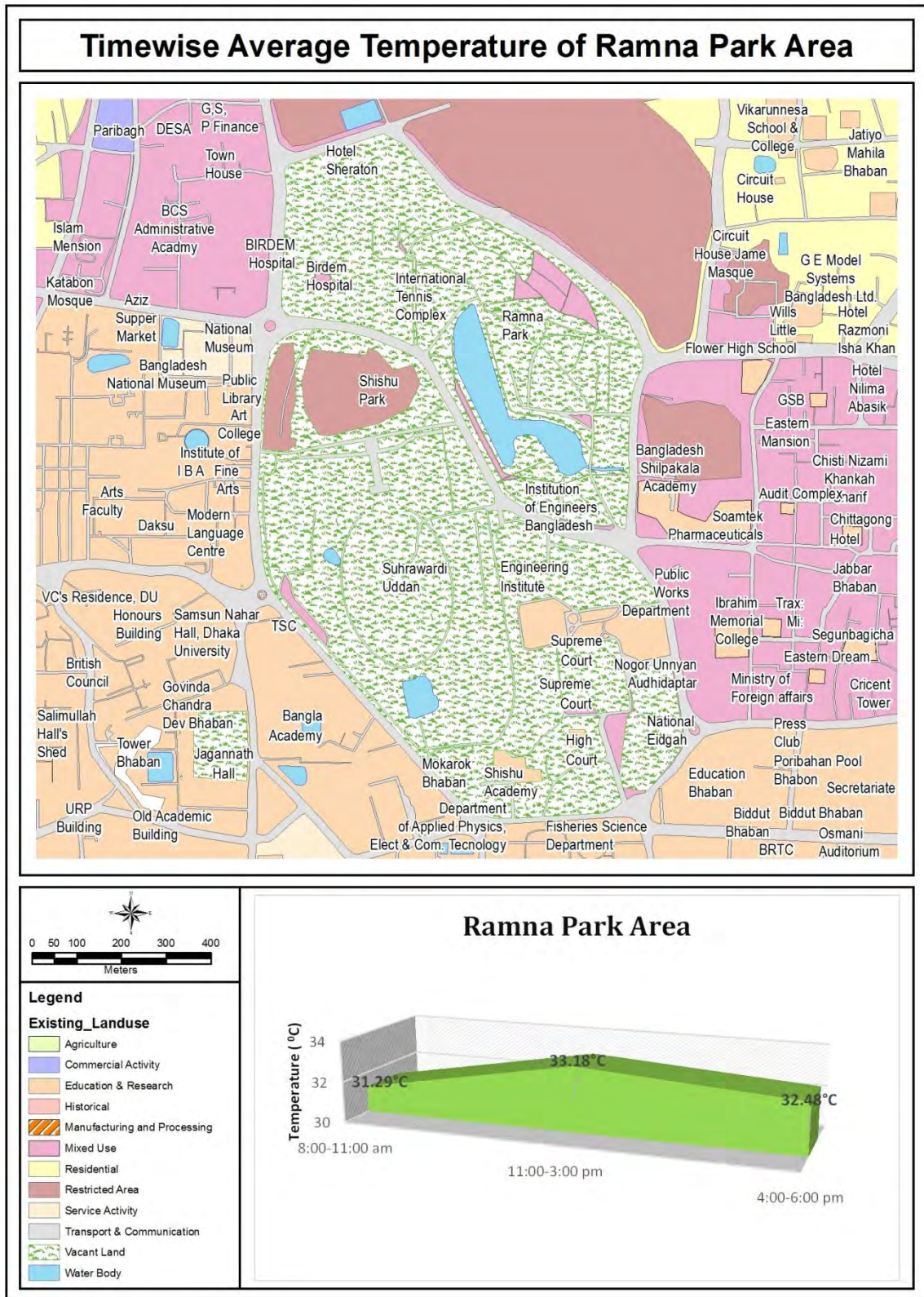


Fig 5.5: Average Temperature at different time of the day at Ramna Park Area

Source: Field Survey' 14

Table 5.3 above shows the average temperature in study areas with greenery integrated walkway- Manik Miya Avenue and Ramna Park Area. The temperature has been captured with Hydro meter. The temperature noted as hourly basis for the five study areas. Then been averaged for two green walkway and without greenery walkway. The following table shows the temperature of without greenery walkway areas. The observation shows that, in the morning, the thermal condition remains cooler in both type of places. As the time goes away, the temperature also increases. At the mid day, temperature reaches at the highest point. But the shady areas hold lower temperature than the sunny areas throughout the day. GIS maps also show average temperature and humidity of two greenery integrated pedestrian way.

Table 5.2: Average Temperature Captured in Kakrail, Maghbazar and Jatrabari.

Walkway Without Greenery	
Time of the day	Temperature (average)
8:00 am-9:00 am	30.89° C
9:00 am-10:00 am	31.72° C
10:00 am- 11:00 am	32.28° C
11:00 am-12:00 am	33.59° C
12:00 pm-1:00 pm	34.49° C
1:00 pm-2:00 pm	36.74° C
2:00 pm-3:00 pm	36.97° C
3:00 pm-4:00 pm	35.26° C
4:00 pm-5:00 pm	34.48° C
5:00 pm- 6:00 pm	33.61° C

Source: Field Survey' 14

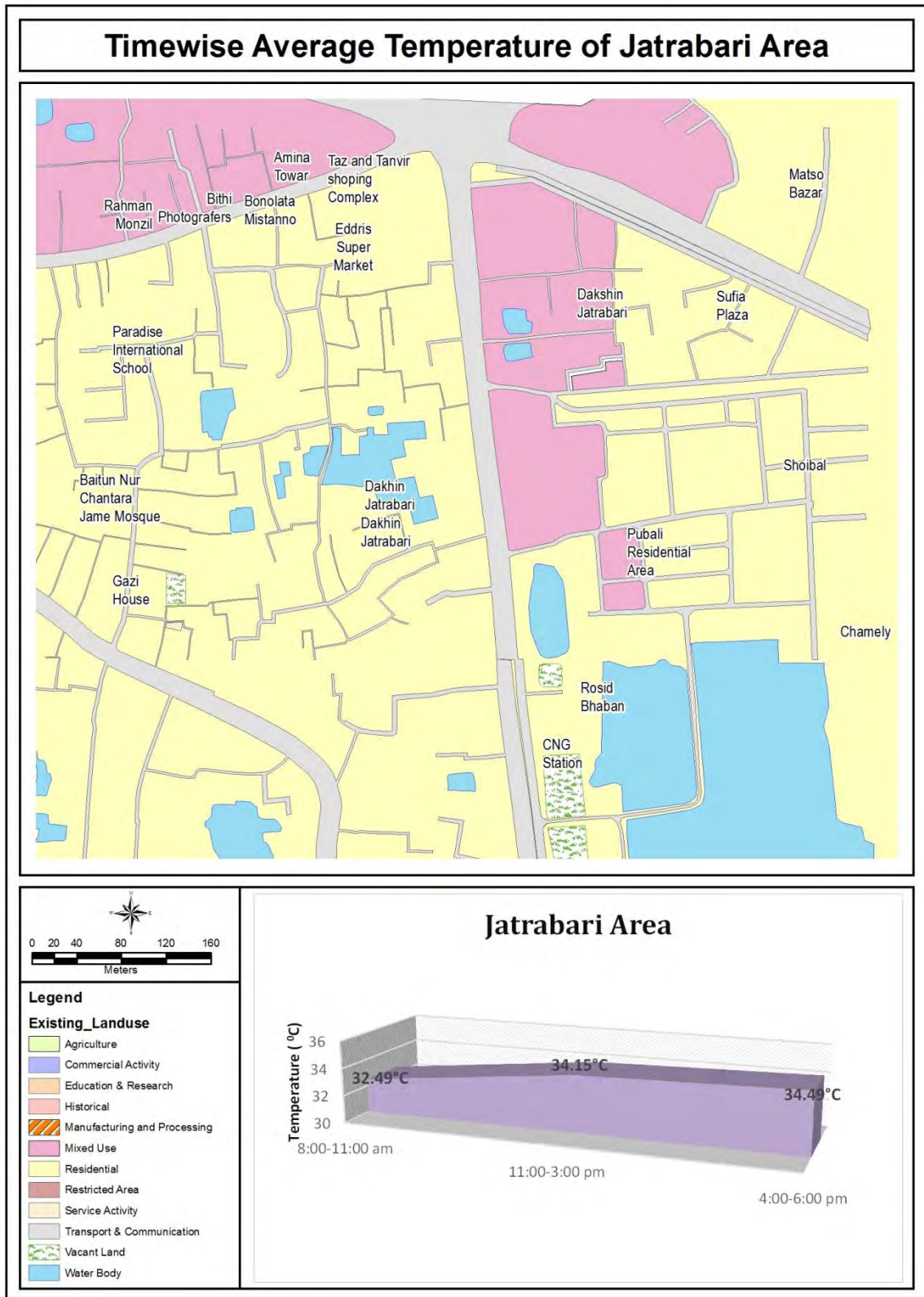


Fig 5.7: Average temperature at Jatrabari area at different time of the day

Source: Field Survey,2014.

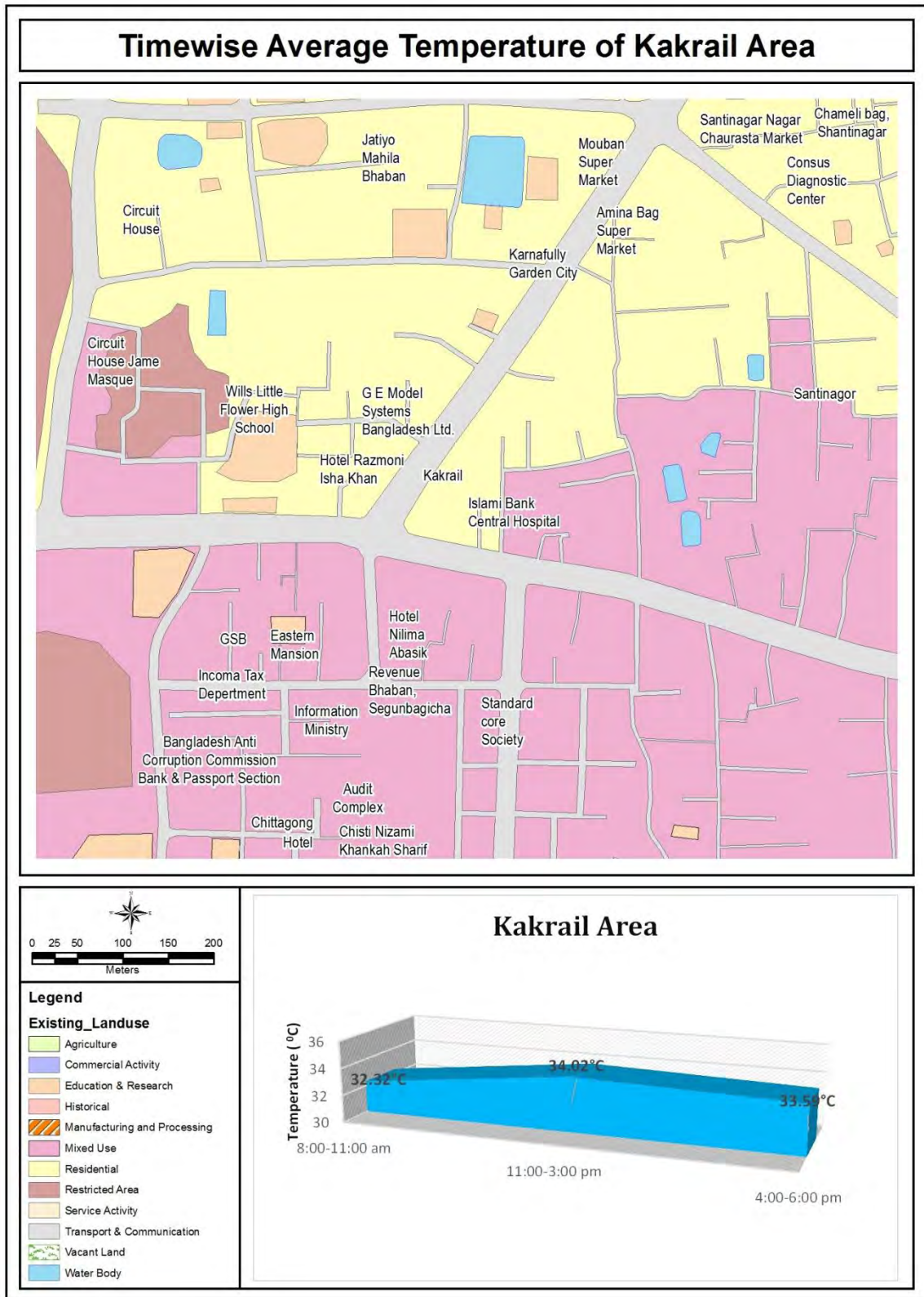


Fig 5.9: Average temperature at different time of the day at Kakrail Area

Source: Field Survey, 2014.

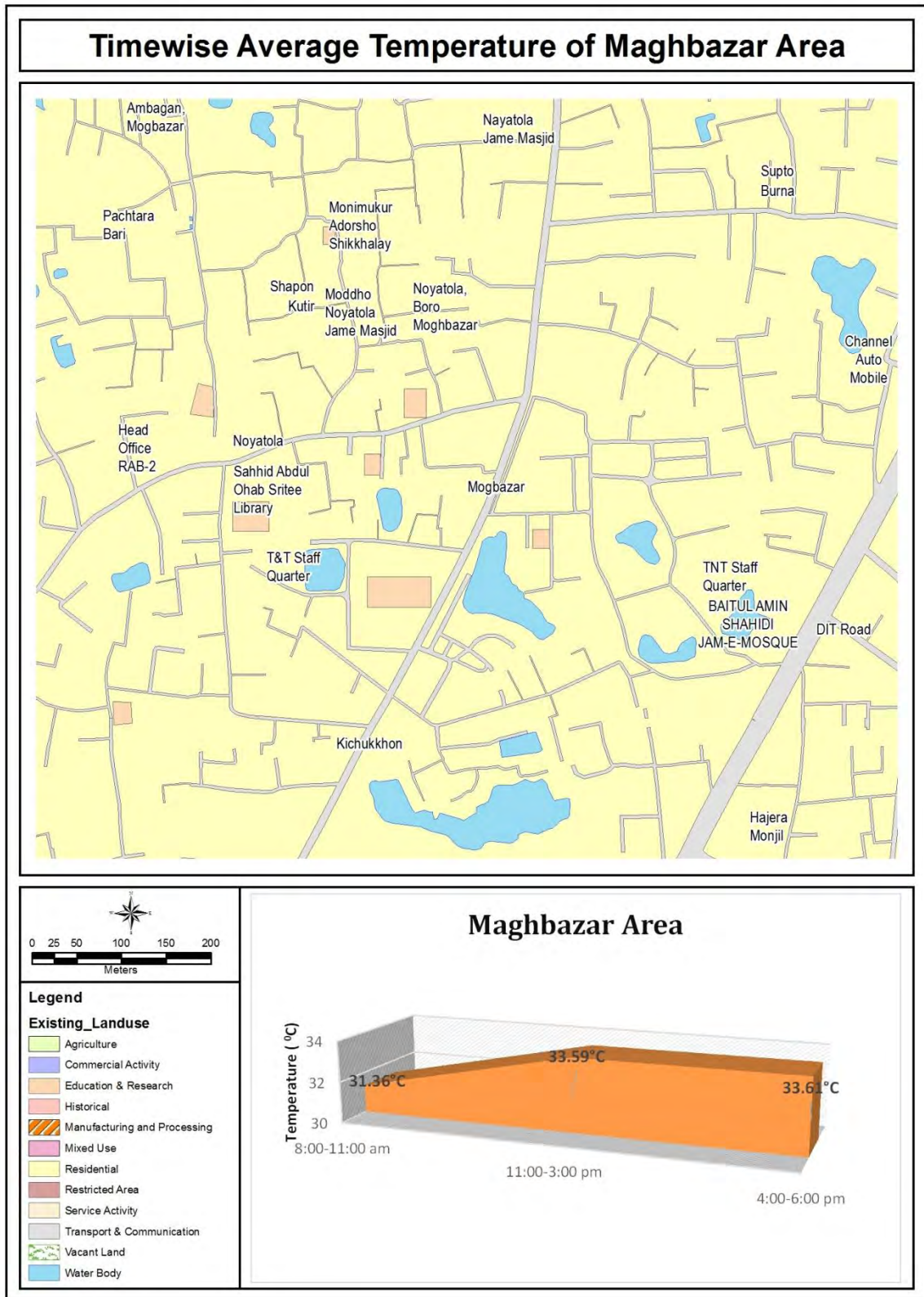


Fig 5.10: Average temperature of Maghbazar at different time of the day

Source: Filed Survey, 2014.

Though the average temperature for three places may show a sensible thermal condition, Jatrabari had the highest temperature of 37.21⁰C at the time of survey. This temperature was really very uncomfortable for pedestrians. The following table shows the differences of temperature between greenery integrated walkway and walkway without greenery. From the survey, it has been evident that, a walkway with large tree provides a shady, cooler and comfortable walkway to the pedestrians, which pedestrians desire most to walk for a long time. The temperature is almost 2⁰C less in green areas than the opposite throughout the day.

Table 5.3: Difference between Average Temperature in Greenery Integrated and Without Greenery Walkway.

Time of the day	Differences Between Two Types of Places	Time of the day
8:00 am-9:00 am	0.80° C	8:00 am-9:00 am
9:00 am-10:00 am	0.84° C	9:00 am-10:00 am
10:00 am- 11:00 am	0.94° C	10:00 am- 11:00 am
11:00 am-12:00 am	1.31° C	11:00 am-12:00 am
12:00 am-1:00 am	1.57° C	12:00 am-1:00 am
1:00 am-2:00 am	1.72° C	1:00 am-2:00 am
2:00 am-3:00 am	1.82° C	2:00 am-3:00 am
3:00 am-4:00 am	1.37° C	3:00 am-4:00 am
4:00 am-5:00 am	1.22° C	4:00 am-5:00 am
5:00 am- 6:00 am	1.13° C	5:00 am- 6:00 am

Source: Field Survey' 14

From the observation survey, it has been evident that, tree shading has the ability to decrease the temperature of air. In locations with warm to hot conditions, shade must be considered at the urban scale and viewed as a public need in terms of environmental quality and as a walkability factor. Moreover, the cooling rate of greenery integrated area is faster than the area without greenery.

5.3.2 Humidity in Study Areas

Humidity is intensively related to temperature. In summer season, temperature is high and humidity is lower. On the other hand, in winter, the situation remains vice-versa. Outdoor comfort level is very closely related to humidity level in the air. If the humidity is high, the environment is cool. If humidity is low, it causes sweating and warm weather condition. In the following diagram, the humidity level is shown for greenery integrated walkway which is relatively high and in comfortable level in morning and evening time for the pedestrians. From 8:00 am to 12:00 am humidity level remains 57%. In the mid of the day it decreases to 6% and then it rises from 51% to 54% in the evening.

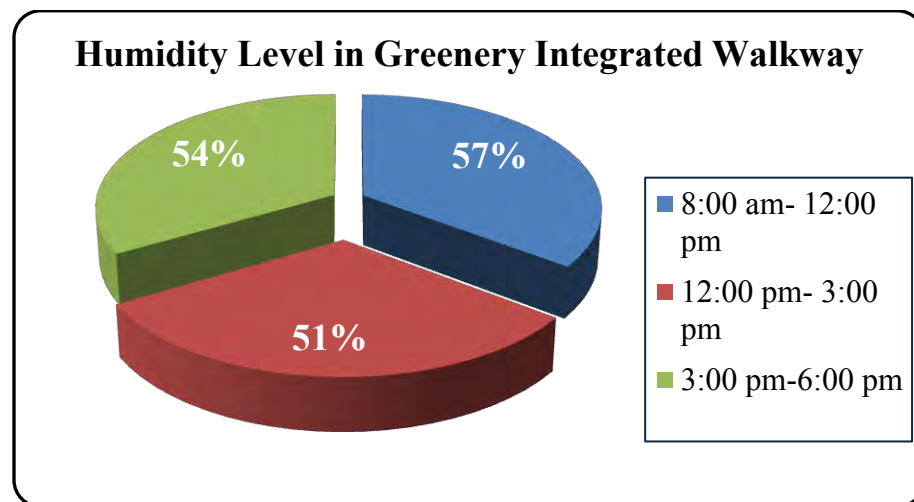


Fig 5.11: Average Percentage of Humidity in Manik Miya Avenue and Ramna Park Area.

Source: Field Survey, 14

The chart shown in following represents the humidity level for the walkway without greenery. Here the humidity level is lower than the walkway with greenery. For that reason, these areas- Kakrail, Maghbazar and Jatrabari are much uncomfortable for the pedestrians. Humidity means the water level in the air. Comfortable level of humidity feels the pedestrians to walk with ease. In greenery integrated walkways, humidity level remains in comfort level for pedestrians.

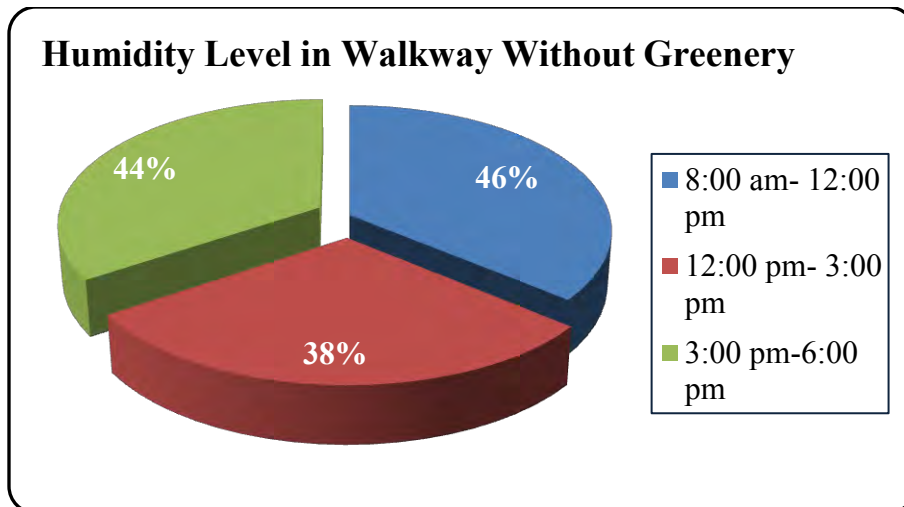


Fig 5.12: Average Percentage of Humidity in Kakrail, Maghbazar and Jatrabari Area.

Source: Field Survey, 14

In the morning time, humidity level is less in the sunny areas than the shady areas. As the temperature increases, humidity level also decreases. In the evening, from 3:00 pm- 5:00 pm, the average humidity level is 44%. At the mid of the day, the humidity level downs to the highest level, which is 38%. In this climate condition, walking is very difficult as the environment is very uncomfortable. In greenery integrated areas humidity remains tolerable in the day time. So it helps pedestrians to walk in a cool and comfortable way.

In the maps showing average humidity illustrates that Manik Miya Avenue had highest humidity at the morning and lowest at the evening which are respectively 53% and 49%. On the other hand, another greenery integrated study area Ramna Park had highest 51% humidity level in the morning and lowest in the evening which was 48%.

At Jatrabari lowest average 34% humidity level recorded from 11:00am-3:00pm. Highest was 42% there. 44% highest humidity level was in Kakrail and Maghbazar. And 39% and 36% were lowest humidity level respectively in both places.

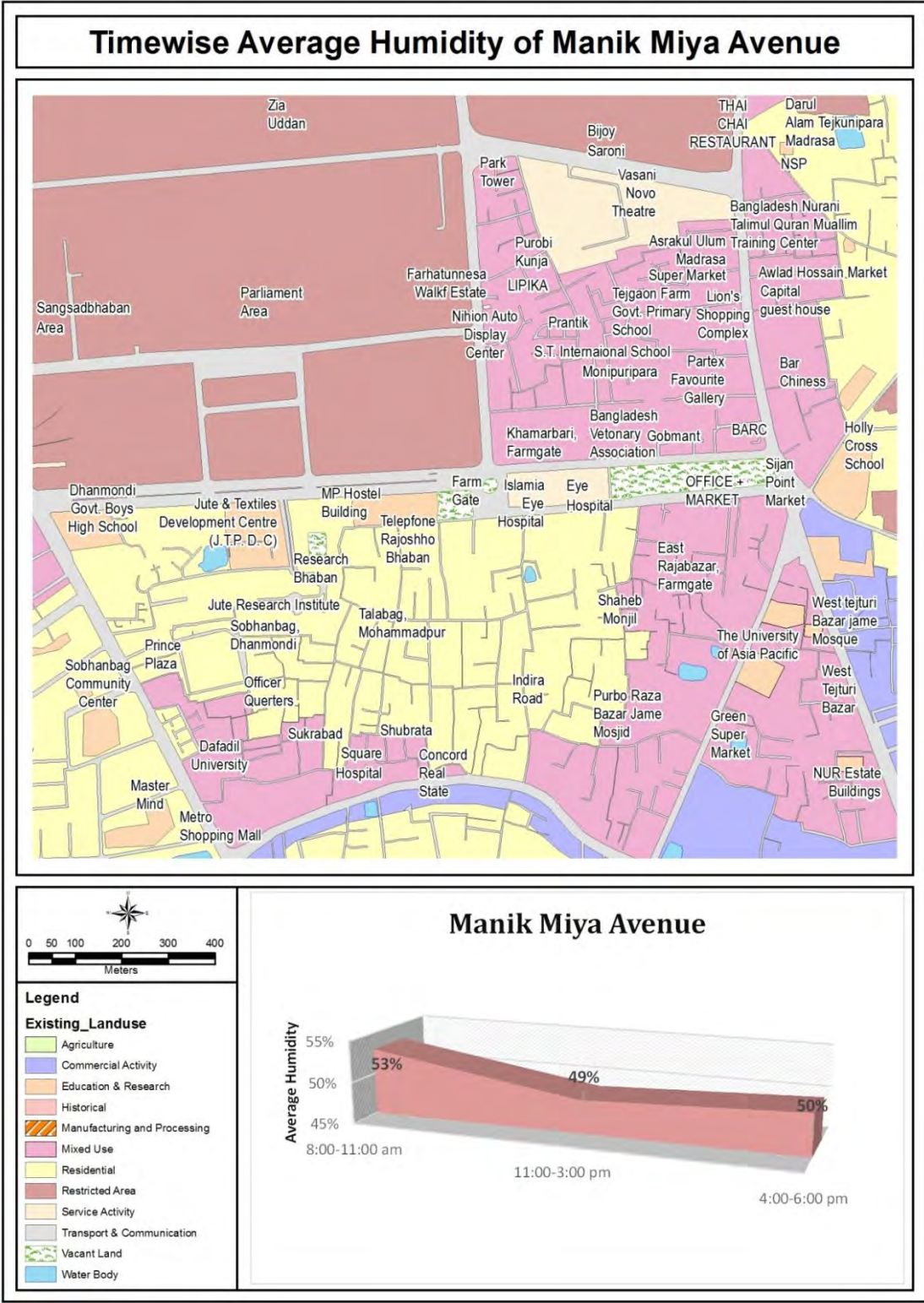
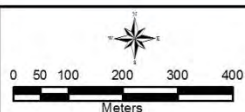
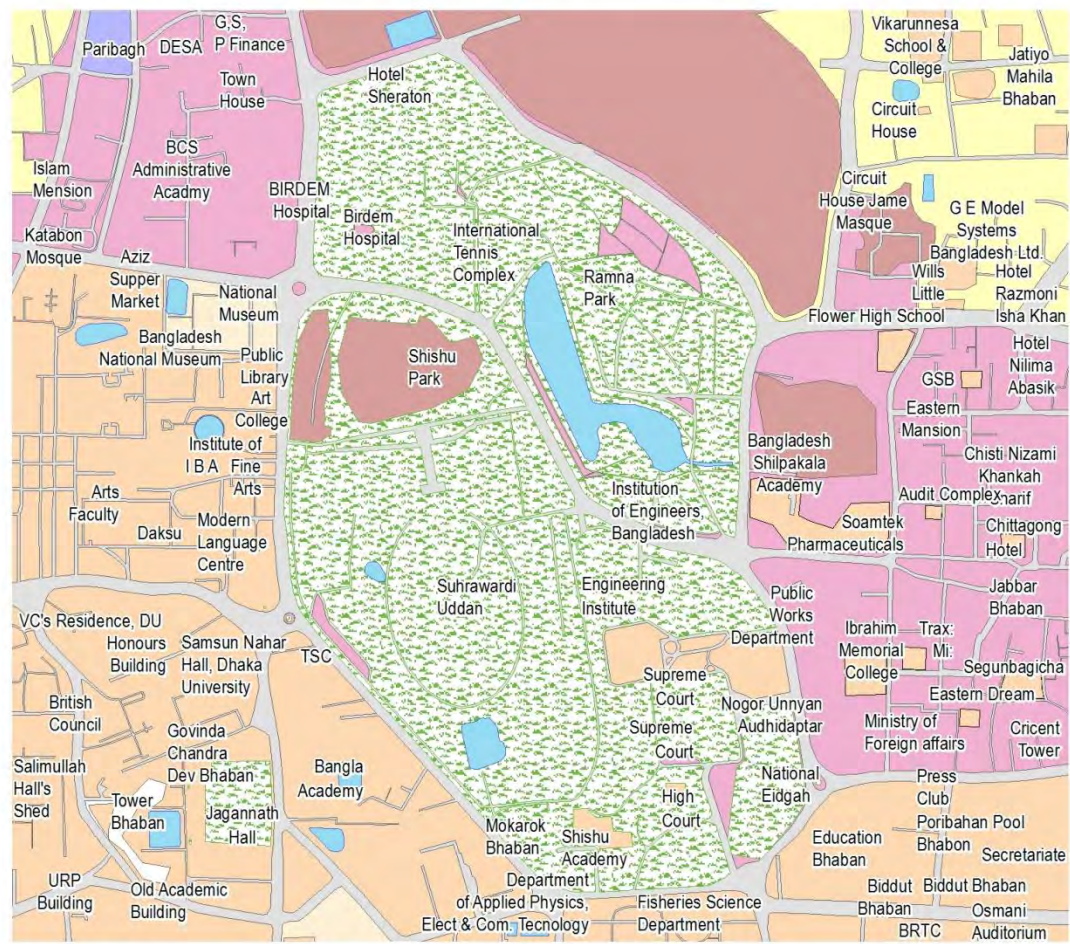


Fig 5.13: Average Humidity at different time of the day at Manik Miya Avenue

Source: Field Survey' 14

Timewise Average Humidity of Ramna Park Area



Legend

Existing_Landuse

■	Agriculture
■	Commercial Activity
■	Education & Research
■	Historical
■	Manufacturing and Processing
■	Mixed Use
■	Residential
■	Restricted Area
■	Service Activity
■	Transport & Communication
■	Vacant Land
■	Water Body

Ramna Park Area

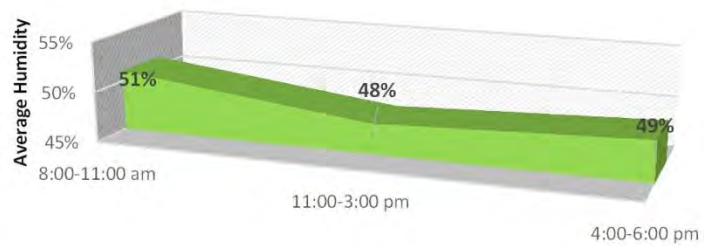


Fig 5.14: Average Humidity at Ramna Park area at different time of the day

Data Source: Field Survey, 2014.

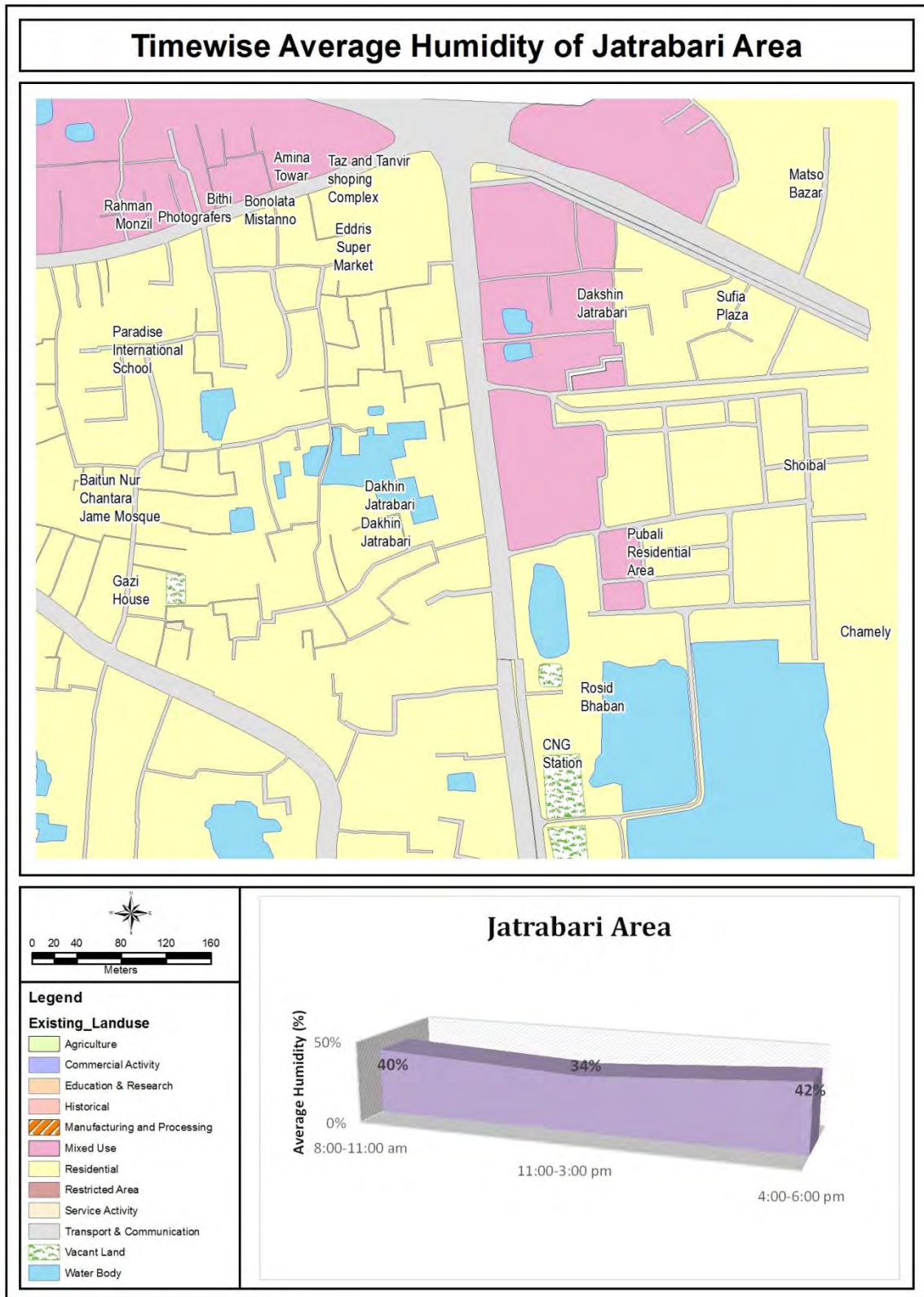


Fig 5.15: Average humidity at Jatrabari area at different time of the day

Data Source: Field Survey, 2014.

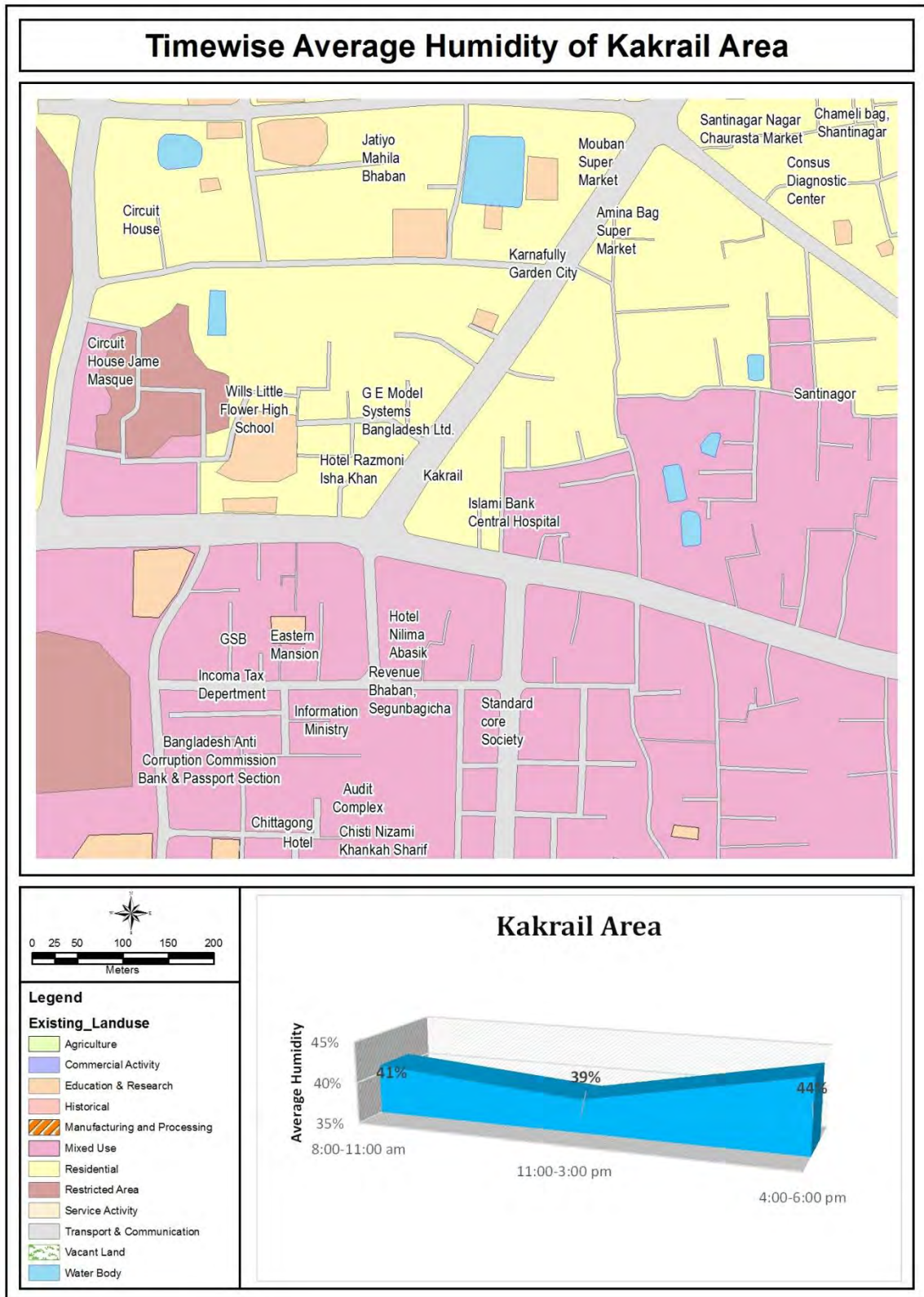


Fig 5.16: Average humidity at different time of the day at Kakrail

Data Source: Field Survey, 2014.

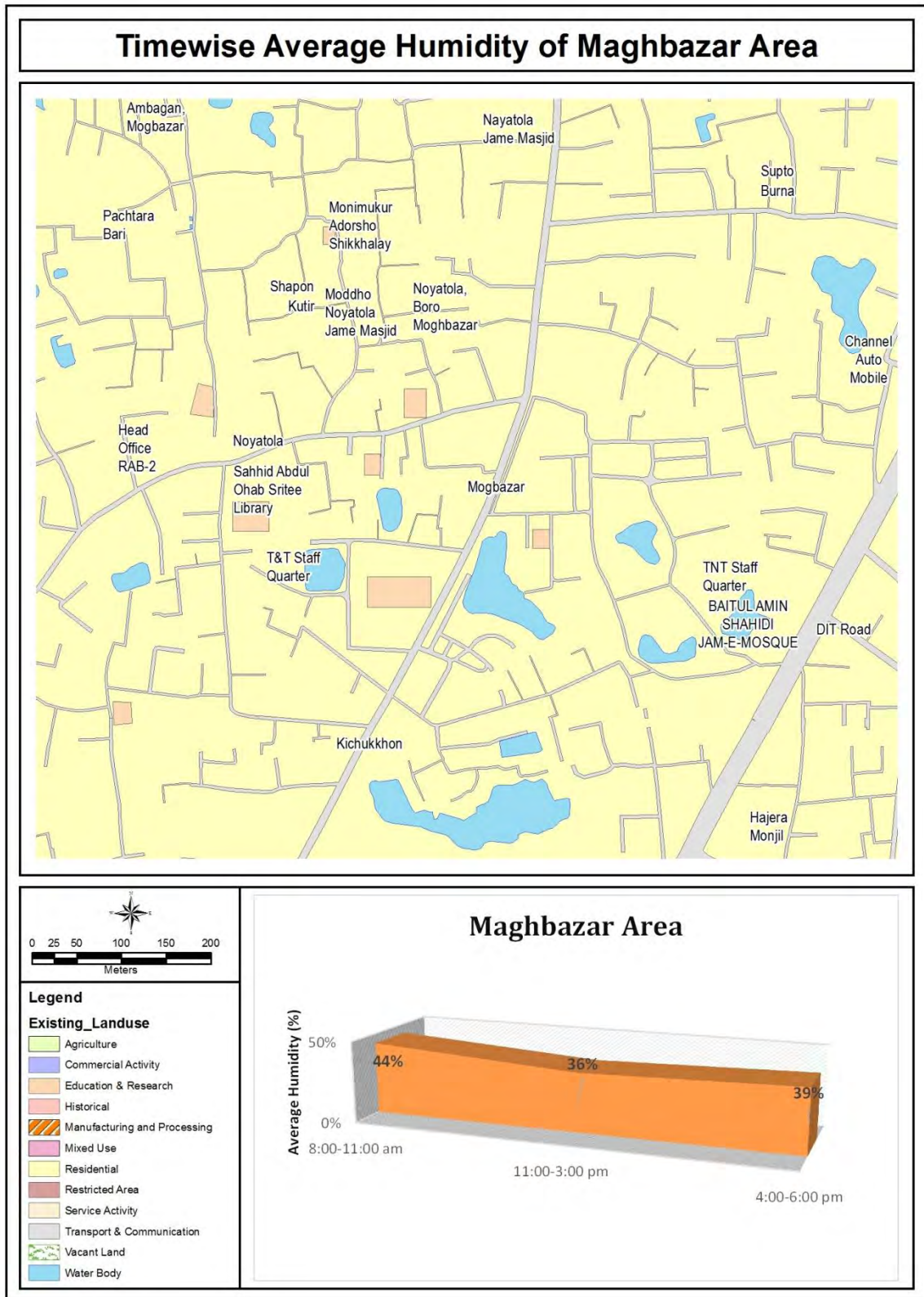


Fig 5.17: Average humidity of Maghbazar at different time of the day

Data Source: Field Survey, 2014.

5.4 Evaluation of Momentary Climate Condition in Study Areas

In contrast to the measurement analyses, the interview results indicated a significant relationship between the momentary perception of the microclimate and the existing amount of greenery in a street. Respondents generally perceived momentary thermal conditions in streets with greenery as more comfortable than in streets without greenery. We draw this conclusion from both, the evaluation of momentary, single parameters, e.g. temperature, sun, humidity and wind, and the evaluation of the momentary microclimate in general.

Table 5.4: Evaluation of the Momentary Microclimate Conditions in Study Areas

Respondents Opinion	Percentage of Respondents				
	Street with greenery		Street without greenery		
	Manik Miya Avenue	Ramna Park Area	Kakrail	Maghbazar	Jatrabari
Very uncomfortable	0	0	19%	17%	39%
Uncomfortable	0	0	47%	46%	43%
Neutral	9%	32%	19%	24%	14%
Comfortable	78%	56%	10%	11%	4%
Very comfortable	13%	12%	5%	2%	0%

Source: Field Survey'14

Interestingly, even though people evaluated momentary microclimates more comfortable in streets with greenery, they were hardly aware of the positive influence of street greenery on their thermal perception. This insight is based on the analyses of the mental maps, where 78% of the respondents in Manik Miya Avenue and 56% respondents in Ramna Park Area attributed their thermally comfortable zones to the presence of green. At the same time, 47% of the respondents in Kakrail, 46% in Maghbazar and 43% in

Jatrabari accounted their walkway as uncomfortable. In Manik Miya Avenue and Ramna Park area, no respondents accounted the both area as thermally uncomfortable. Moreover some people thought that Manik Miya Avenue is more suitable and comfortable to walk than any other areas in Dhaka city. The respondents also replied that their zones of comfort and discomfort within the street canyon would depend on the time of the day. This indicates that people are aware of their choices to walk on the sunny or the shady side of the street and confirms earlier studies.

5.5 Evaluation of Green Street Design

In the time of questionnaire survey, people significantly valued the presence of greenery in aesthetic terms, independent from microclimatic aspects. When asked for the evaluation of the green design of the street, 74% of the respondent in streets of Manik Miya Avenue qualified the design of the walkway as very pleasant; whilst no pedestrian account the walkway of Jatrabari as pleasant, which is without greenery, qualified the design as very unpleasant. It was found that street greenery raises aesthetic appreciation of streetscape – independent from microclimatic aspects.

Table 5.5: Evaluation of the Green Street Design in Study Area

Respondents Opinion	Percentage of Respondents				
	Street with greenery		Street without greenery		
	Manik Miya Avenue	Ramna Park Area	Kakrail	Maghbazar	Jatrabari
Very unpleasant	0	0	26%	13%	21%
Unpleasant	0	3%	42%	48%	57%
Neutral	13%	17%	17%	29%	21%
Pleasant	13%	69%	12%	8%	1%
Very pleasant	74%	11%	3%	2%	0%

Source: Field Survey' 14

In Ramna Park area 69% respondents considers the walkway as pleasant and 11% of them told that the walkway is very pleasant especially in the evening. A few respondents pointed the road as unpleasant because of the illegal grabbers and street hawkers. In Maghbazar and Kakrail area respectively 48% and 42% respondent replied the walkway unpleasant. The worst condition among the five study areas is of Jatrabari. 57% of the pedestrian recognized it as unpleasant and 21% of the said it very unpleasant. Female and aged pedestrians of this area commented negatively. They said that at the mid of the day the area become totally unsuitable for walking. That's why at this time of the day the road has the long time traffic jam. But often people are seen to walk endangering their life to a great threat to fulfill their needs.

5.6 Conclusion

From the questionnaire survey and observation survey in different areas of Dhaka City, it had been resulted that greenery mitigates the heat island not by cooling the air, but by warming the air less. Higher temperature and lower humidity level discourages people to walk. Although people are barely aware of the Greenery reduces the air temperature by direct shading of surfaces. Pedestrians prefer those walkways more which are greenery integrated and provided with cool, comfortable and esthetical pleasance. Jay walking is a very big reason for pedestrian accidents in Dhaka city. In spite of having a designated walkway people are always seen to walk haphazardly in the road. As they do not feel a minimum level comfort to walk within the walkway. A greenery integrated walkway can give aesthetically pleasant and comfortable environment to walk throughout the day. At the same time it can provide safety by encouraging people to keep themselves within the walkway.

Chapter 6

Chapter-6

Impact of Greenery on Pedestrian Walking Behavior

6.1 Introduction

An important part of every town is its transport system and particularly its road system for affective smooth and efficient movement of people and commodities. For good accessibility, the circulation system of a city should meet certain basic requirements [33]. Similarly, for the pedestrians, a continuous, comfortable and pleasant walkway is the basic prerequisite. From the data gathered from interview and observation survey, results indicated that people in general perceived thermal conditions in streets with greenery to be more comfortable than in streets without greenery, even though they were hardly aware of this positive influence of street greenery on their thermal comfort. Additionally, the study found that street greenery raises aesthetic appreciation of streetscape – independent from microclimatic aspects. Moreover, people significantly valued the presence of greenery in aesthetic terms as common people have limited knowledge on climate impact of greenery in pedestrian way. The study results suggest that street greenery contributes in improving physical and psychological thermal comfort and raising aesthetic appreciation of streetscapes. Green infrastructure has the ability to reduce urban heat effect and improve thermal comfort on various scale levels [51-54]. Greenery in urban streets, such as trees, ameliorates thermal conditions for pedestrians [53, 55-57].

By giving insight into physical and psychological impacts of street greenery on human thermal comfort, the research findings contribute to develop design guidelines for thermally comfortable streets. Furthermore, they can be used for strengthening urban planning policies to implement street greenery in existing and new neighborhoods. Interestingly, even though people evaluated momentary microclimates more comfortable in streets with greenery, they were hardly aware of the positive influence of street greenery on their thermal perception. This indicates that people are aware of their choices

to walk on the sunny or the shady side of the street and confirms earlier studies. Pedestrian safety is major issue in effective transportation planning. Walkway with tree barrier can provide a visual and attractive way to encourage pedestrians to walk within the walkway.

6.2 Demographic Information of the Respondents

6.2.1 Respondents' Age Group

In the questionnaire survey, to avoid unwanted intervention in the analysis of the data, the respondents were selected keeping in mind their age. I assumed the age group from 15 years to 50 above. Between this age group, the question answers can be got relevant to the study and the analysis can give a fruitful result.

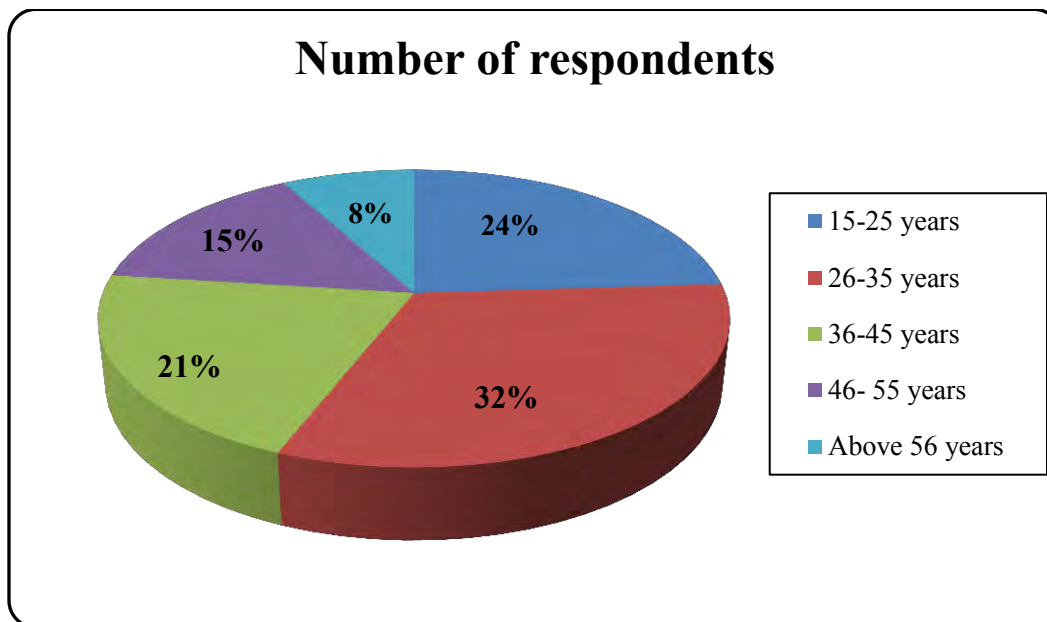


Fig 6.1: Percentage of Respondents Based on Age Group

Source: Field Survey' 14

In the time of observation survey; it has been identified that the number of specific age group were dominant at different time of the day in different places. In the morning time school going and office going people were in dominant number. But in evening, comparatively aged people were in the way for recreational hangouts. Aged persons walk

in group most of the time. In holidays parents went out with the children for site seeing especially in the green pedestrian way as they give esthetical pleasant feeling to all aged persons. But young aged people from fifteen to twenty five years are seen to walk all the day through in green walk way zones.

6.2.2 Respondents' Occupation

As the study areas (Jatrabari, Kakrail, Moghbazar, Manik Miya Avenue and walkways around Ramna Park) are of different characteristics, pedestrians of these areas also show different characteristics. However, in this research, all types of pedestrians were being focused.

In the time of questionnaire survey, almost 33% were service holders, 27% were students, 28% were businessmen and 12% were day labor. Students were of different classes. In Manik Miya Avenue and Kakrail area, school and college going students were dominant. In Jatrabari, Maghbazar and kakrail, businessmen and service holder number were higher than other areas. But it was always a major concern in questionnaire survey to survey all profession pedestrians to find out the actual scenario.

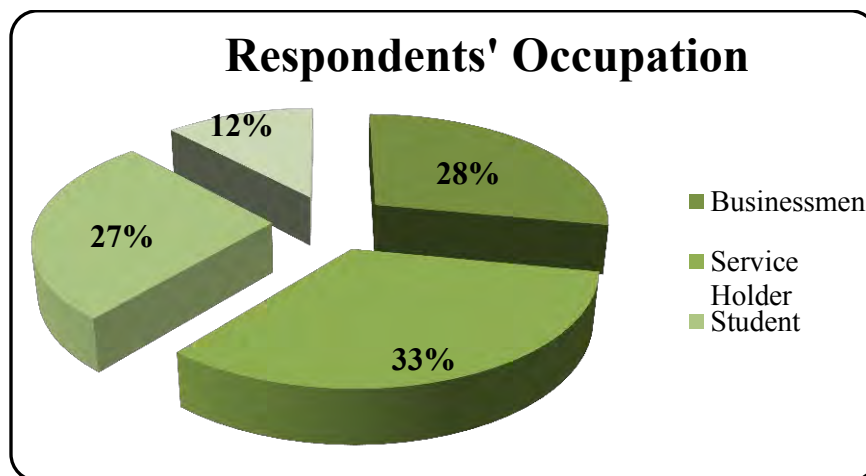


Fig 6.2: Percentage of Respondents Occupation in Study Area

Source: Field Survey' 14

To choose a mode for transportation, access and cost are very important factors. That why, in a pedestrian questionnaire survey, it is obvious to know the occupation of the respondents. Without knowing the occupation of an area, any plan can be useless. In the

survey questionnaire, a very early question was about profession. The above chart represents the percentage of respondents' occupation at the time of the survey.

6.3 Respondents Opinion

6.3.1 Preference of Shade

In relation to the main objective of the study, which is to determine how shade improvements would benefit walking in summer, the following finding was attained: the majority of the respondents value shade. Fig.1 presents the results from the question “*Do you look for shaded walkways in sunny days?*”

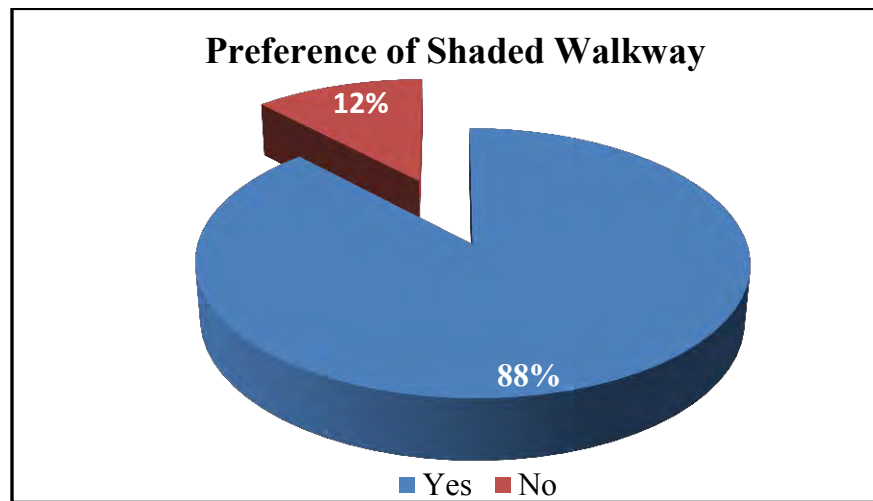


Fig 6.3 Distribution of responses to the question: Do you look for shaded walkways in sunny days?

Source: Field survey'14

From the questionnaire survey, it has been found that 88% of the respondents answer that they prefer shaded walkway in a sunny and hot warm day. The rest 12% responds “No”. The respondents who answers negative, most were unable to understand the question or in a hurry. Some of them were school students, not serious about the survey. However, the large share of the respondents think that greenery is an essential part to make the walking pleasurable and comfortable.

6.3.2 Reasons behind Choosing Greenery Integrated Walkway

The respondents were asked to mention the reason why they choose a walkway with greenery. From the questionnaire 39% respondents replied that they use it for the shade. Another 27% choose it because of comfortable weather and 12% for better air flow. More importantly 22% choose the option aesthetical pleasance.

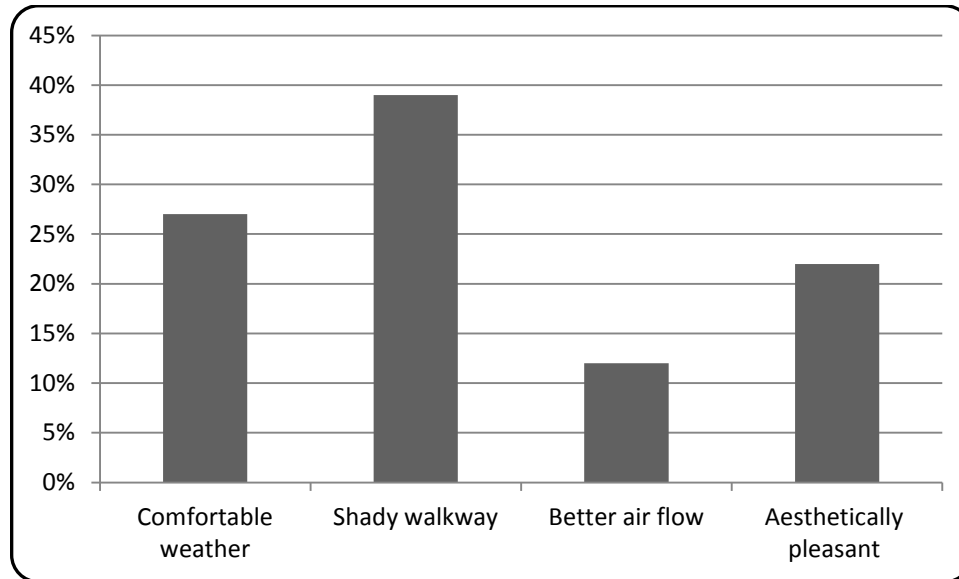


Fig 6.4: Reasons for Choosing Green Walkway

Source: Field survey'15

6.3 Walking Time in Greenery Integrated and Without Greenery Walkway

The impacts of solar exposure (sun, shade) on the time people are willing to walk. It also explores the influence of different trip purposes on the willingness to walk (in the sun and in the shade). This section analyze the impact of the existence or the absence of shade, in summer, in the maximum time that people are willing to walk without stopping (one trip) with varied destination purposes (trips with and without a pre-defined destination).

The destination has been divided into two sections according to the need of the pedestrians.

Trip- 1: With no destination specified (also called abstract destination)

Trip- 2: With a specific destination: a) to work or to school; b) to recreation or health activities.

6.3.1 Walking Time for Abstract Destination

From the questionnaire survey it has been observed that, walking time varies in green walkway and without greenery walkway. The majority of the respondents were willing to walk in the sun for a maximum time of 5-15 minutes, which holds for 70% of all respondents in selected three areas: Jatrabari, Maghbazar and Kakrail, while their willingness to walk in the shade varies between 15-30 minutes to 45-60 minutes. 70% of all respondents were interested to walk for 30-45 minutes in a shady walkway and 17.20% of respondents were willing to walk for maximum 60 minutes in greenery integrated area. These percentages show that a greenery integrated walkway can change the people's perception on walking.

People sometimes walk without any reason and without any destination. Table 6.1 summarizes walking-time frequencies for trips without stopping - with no destination specified. The variable was:

Abstract assumption: For how long would you consider walking? (Walking-time “Sun” and walking-time “Shade”).

Table: 6.1- Walking Time for Abstract Destination

Destination (Abstract)				
	Walking time (Sun)		Walking time (Shade)	
	Count	Percentage	Count	Percentage
5-15 min	81	16.20%	0	0%
15-30 min	389	77.80%	63	12.60%
30-45 min	23	4.60%	351	70.20%
45-60 min	7	1.40%	86	17.20%
Total	500	100%	500	100%

(Source: Field Survey'14)

The analysis results show that people's willingness to walk varies with the environment of the walkway. The more comfortable the environment is, the more people are in the walkway.

6.3.2 Walking Time for Specified Destination

People walk for many reasons: to go to school or to get to work places, to go to relatives' house etc. People also walk for recreation and health benefits or for the enjoyment of being outside. Some pedestrians must walk to transit or other destinations if they wish to travel independently. In this case destinations were classified into two categories:

- a) To work or education;
- b) For recreation, health or other activities

Generally people who walk for job or to school, college or universities, are seen in some specific time, especially in the morning and evening. But who walk for recreational or health purpose, are seen throughout the day.

In the following table, percentage shows the walking time of people in sunny and shady walkway. The percentage was being adjusted for five study areas.

Table 6.2: Walking Time for Specific Destination (For Work or study)

Destination: Specific (Work or Education)				
	Walking time (Sun)		Walking time (Shade)	
	Count	Percentage	Count	Percentage
5-15 min	57	11.40%	22	4%
15-30 min	432	86.40%	67	13.40%
30-45 min	11	2.20%	394	78.80%
45-60 min	0	0.00%	17	3.40%
Total	500	100%	500	100%

Source: Field Survey'14

Table 6.2 summarizes walking time frequencies for trips without stopping - with a specific destination. The main variable was:

- ✓ For how long would you consider walking to go to work / school?
Walking-time “Sun” and walking-time “Shade”.

86% respondents were ready to walk for 15-30 minutes in a walkway without greenery. On the other hand, 78% of respondents were highly interested to walk for 30-45 minutes

in a shady walkway. Another 3.40% answered that they can walk for highest 60 minutes to go to work places or to school or colleges. As we know, when people walk for work or school or colleges, they remain in hurry. But many respondents told that, if the walkway is provided with a healthy walking environment, they will manage to walk for long time, which will give them financial as well as health benefits. Only 2% people in study areas without greenery will to walk for 45 minutes. And respondents think it impossible to walk for 60 minutes in those areas without greenery.

The trip destination influences the walking-time “Shade”. When the destination is work/school, the time that the majority of respondents are willing to walk in the shade is 30-45 minutes (in accordance with walking-time “Shade” for trips with no destination specified). On the other hand, when the purpose of the trip is recreation then the majority of the respondents (57.40%) raise their willingness to walk in the shade up to 60 minutes. The percentage of respondents to walk for 30-45 minutes is also significant, which is 31.80%. Only 39.40% respondents were eager to walk for 30 minutes in a sunny walkway.

Table 6.3: Walking Time for Specific Destination (recreation, health or others)

Destination: Specific (Recreation/Health/Others)				
	Walking time (Sun)		Walking time (Shade)	
	Count	Percentage	Count	Percentage
5-15 min	216	43.20%	6	1.20%
15-30 min	197	39.40%	48	9.60%
30-45 min	79	15.80%	159	31.80%
45-60 min	8	1.60%	287	57.40%
Total	500	100.00%	500	100.00%

Source: Field Survey’ 14

The walking time for abstract destination and specific destination varies for both greenery integrated walkway and walkway without greenery. People walk for many reasons. According to their needs and time they choose the mode of travel. Most of the cases, it

had been seen that, walking time in greenery and without greenery areas is less for specified destinations than abstract destinations. This is because, in case of specified destinations, people remain in hurry or in emergency. However, people prefer walking in a shady, cool and comfortable walkway for any type of destination.

6.4 Walking Time in Respect of “Gender”

It is evident that mode is influenced by gender and female are more inclined to choose a more comfortable mode. This study also complies with the previous study that females are always interested in choosing a safe and comfortable environment to move. Females consider walking more than travelling in any transport if the walkway is provided with a convenient and comfortable environment.

From the survey, it was found that, the presence of greenery has a very strong impact on gender. In greenery integrated walkways, for abstract and specific destination, percentages of walking for 30 minutes for male and female are respectively 38.12% and 37.89%. This indicates that both male and female pedestrians like to walk in a shady and cool walkway.

Table 6.4: Willingness to Walk In the Sun and Shade (According To Gender)

Walking Time (By Gender)				
	Walking time (Sun)		Walking time (Shade)	
	Male	Female	Male	Female
	Percentage	Percentage	Percentage	Percentage
5-15 min	12.26%	57.30%	7.90%	30.55%
15-30 min	31.08%	39.10%	24.22%	29.00%
30-45 min	48.19%	3.60%	38.12%	37.89%
45-60 min	8.47%	0.00%	29.76%	2.56%
Total	100.00%	100.00%	100.00%	100.00%

Source: Field Survey, 14

In sun exposure conditions, only 3.60% of female were willing to walk for 30 minutes. Those who responded to walk in sunny day, told so because of financial condition and

urgency. Majority of 57.30% of female exposed their willingness to walk for only 5 minutes. On the other hand, in same climate condition, 48.19% of male pedestrians were willing to walk for 30 minutes. That means when the climate condition is bad, the percentage varies from male to female. But in a comfortable environment, male and female holds almost the similar percentage in respect to different walking time.

6.5 Walking Time in Respect of “Age”

Walking time in sun and shade is influenced by age to a great extent. The age group from 15 to 30 years holds the higher percentage of pedestrians than the age group from 40 to 50 and above. The table-7 shows the mean values for walking-time ”Sun” and walking-time “Shade “, respectively, for all trip destinations, as a function of the “Age”.

Table: 6.5 Willingness to Walk In The Sun (According To Age)

Walking Time (By Age)							
		15-20 yrs	21-25 yrs	26-30 yrs	31-40 yrs	41-50 yrs	51 and above
Walking time (Sun)	5-15 min	51.78%	53.76%	62.23%	69.00%	95.04%	96.82%
	15-30 min	41.09%	38.16%	29.39%	28.11%	4.59%	3.18%
	30-45 min	7.13%	7.07%	7.38%	2.01%	0.37%	0.00%
	45-60 min	0.00%	1.01%	1.00%	0.88%	0.00%	0.00%

Source: Field Survey’ 14

From the questionnaire survey, it has been found that, in a sun exposure condition, not a single person aged from 15 to above express their willingness to walk for 45- 60 minutes. Only 7.13% of young aged respondents were willing to walk in sun, if there is any emergency. More importantly, all of the respondents of any age group express their willingness to walk highest for 5 to 15 minutes in sun exposure condition. 38.16% and 41.09% of the respondents respectively expressed their willingness to walk for 15 to 30 minutes in a sunny walkway. Walking time 45 to 60 minutes holds 0% share for 50 above

people. That means a very certain percentage of people, specifically age group from 15 to 25, are will to walk in sun for maximum time. The result thus focus on the importance of greenery integrated walkway to encourage walking rather than motor vehicle travelling.

Table: 6.6 Willingness to Walk In the Shade (According To Age)

Walking Time (By Age)							
		15-20 yrs	21-25 yrs	26-30 yrs	31-40 yrs	41-50 yrs	51 and above
Walking time (Shade)	5-15 min	0.27%	2.44%	5.76%	14.57%	15.22%	28.68%
	15-30 min	12.30%	18.06%	20.59%	23.13%	38.70%	46.09%
	30-45 min	30.33%	29.51%	32.83%	33.12%	26.41%	22.22%
	45-60 min	57.10%	49.99%	40.82%	29.18%	19.67%	3.01%

Source: Field Survey' 14

On the other hand, walking through a greenery integrated walk way was found to be very comfortable and enjoyable for the pedestrians. The results from the questionnaire survey, shows very positive attitude of the respondents towards greenery integrated walkway particularly in two study areas- Manik Miya Avenue and Ramna Park area. Manik Miya Avenue is always preferable for walking to the pedestrians for its cool, comfortable environment. Similarly, Ramna Park outside road is also considered for walking to many pedestrians. 46.09% respondents of above 50 years said that they would walk in shade for highest 30 minutes. 57.10% and 49.99% respondents respectively aged 15-20 years and 21-25 years expressed their positive response to walk in shade. 40.82 % respondents of aged 26-30 years were willing to walk for 45-60 minutes in shade.

6.6 Relation between Greenery Integrated Walkway and Pedestrian Volume

Interview on pedestrians in five different places in Dhaka City results indicated that people perceived thermal conditions in streets with greenery to be more comfortable than in streets without greenery, even though they were hardly aware of this positive influence

of street greenery on their thermal comfort. Furthermore, people significantly valued the presence of greenery in aesthetic terms. Walking distances are largely determined by pedestrians based on landscape design, climatic condition, topography and land use pattern [33]. Harsh climatic conditions from rainy or sunny seasons may limit people from walking. Many people prefer to walk long distance for leisure but short distance when in hurry like from bus stops to their offices. Despite the fact that landscape elements such as shade trees, paved walkways and hedges are crucial in promoting pedestrian movement in most urban areas these elements are still lacking. Even in places where pedestrian walkways have been provided and paved, supporting landscape elements both hard and soft have not been considered in term of design and implementation. This has resulted into pedestrian over spilling into vehicular routes that has culminated into traffic accident, conflict and people shying away from walking [34].

Findings show that roads which had adequate provisions of landscape elements (pavements or shade trees) accommodated twice as much as the number of pedestrians along roads with limited or no landscape elements. It is recommended that provision of more walking space, provision of continuous, paved and shaded walkways should be encouraged as a strategy of promoting walkability and livability in these cities.

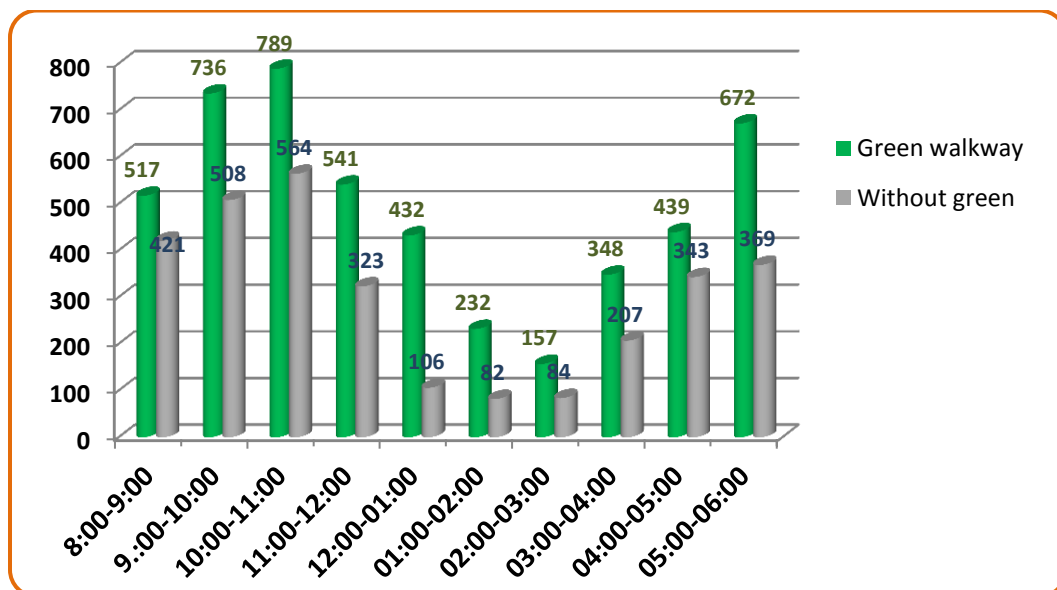


Figure 6.5: Relationship between Greenery and Pedestrian volume

Source: Field Survey'2015.

The table shown above illustrates that the presence of greenery in walkway in Dhaka city highly influences the choice of travelers' to walk or ride. The data were collected from field survey in five study areas. Then the data were being compared between two types of walkway- greenery integrated walkway and without greenery walkway. The result is so obvious. Pedestrian volume is higher in Manik Miya Avenue and Ramna Park combindly, then the walkway in Kakrail, Maghbazar and Jatrabari area throughout the day. At evening, off peak hour for pedestrians, in two types of places volume decrease than morning or evening time. Even though, pedestrian always choose a greenery integrated pedestrian way more than a walkway without greenery.

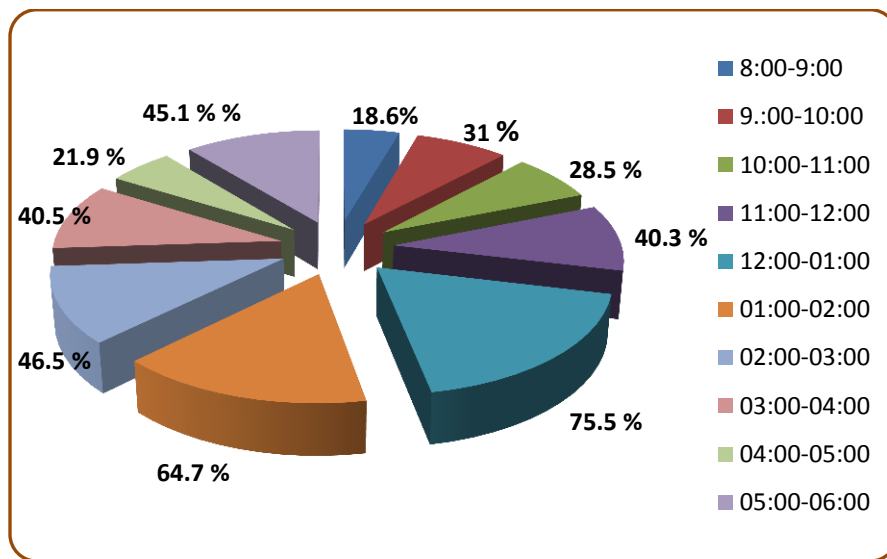


Figure 6.6: Percentage of Pedestrian Volume in Shaded Walkway than Non-shaded Walkway

Source: Field Survey'2015.

The above chart shows the increased percentage of pedestrians in greenery integrated walkway than without greenery walkway. At evening time this gap of pedestrian volume increases up to 75%. On the other hand at morning time it is highest 40%, as the climate condition is almost tolerable in both places. In the evening the volume in greenery integrated areas raises upto 45%. It has been seen that, pedestrian volume is higher in shaded areas through the day than the high tempered, uncomfortable areas. That means pedestrians avoid those places to walk in sunny, hot day.

6.7 Conclusion

From the above observation survey and questionnaire survey results and discussion, it is evident that, pedestrians of all age group always prefer to walk in greenery integrated walkway. The study investigated physical and psychological impacts of street greenery on thermal comfort in five street types with varying vegetation density. As a green walkway gives them shade, cool and comfortable environment, pedestrians' walking time greatly depends on the walk way environment. A comfortable walking environment can reduce the dependency on motor vehicle and thus will deduct the number of vehicles in the road.

Pedestrians always prefer a convenient walkway which will help fast to reach a destination. Preference to walk and walking time of pedestrians depends on some factors- presence of greenery, type of destination, gender, age etc. It has also revealed that females prefer walking as they feel unsafe and inconvenient in public transport. Aged pedestrians also prefer walking for the same reasons. Costs of transportation, easy access are also very strong reasons to choose walking mode. In short, greenery integrated walkway can increase the share of walking to a great extent and decline the dependency on public or private transportation. The questionnaire survey supported that walkers' choice to choose a greenery integrated pedestrian way is higher than a walkway without greenery. So to encourage walking within Dhaka city, it has become mandatory to give emphasis on pedestrian way greenery.

Chapter 7

Chapter-7

Findings and Recommendations

7.1 Findings

Dhaka, one of the most densely populated cities in the world, has faced severe traffic congestion issues for quite some time. The uncontrolled population growth, unplanned spatial growth of the city, unplanned development, lack of a quality public transit system, insufficient amount of road network and insufficient infrastructure facilities for walking and biking are some of the main causes of this severe traffic congestion in Dhaka. People in Dhaka are losing their productive hours stuck in traffic everyday which is putting an adverse negative impact in the national economy.

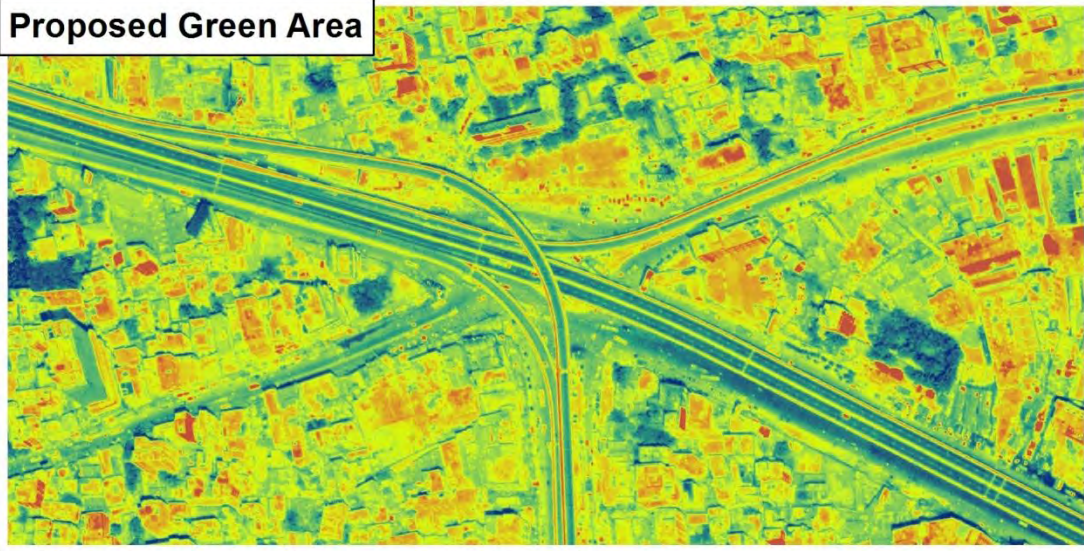
The urban fabric of Dhaka, which mainly consists of dense and mixed use developments, had made many trip lengths within walking distances or at least within distances that are accessible through non-motorized transport. It is believed that up to 60 per cent of the trips in the city are made on foot, which is very high compared to most mega cities in the region. Although, a huge amount of the trips made in the city consists of walking trips, it is unfortunate that pedestrians in Dhaka has to go through unfriendly walking conditions due to the poor and unsafe walking conditions. Some of the reasons that are causing the poor walking condition include - lack of continuous sidewalks, poorly maintained sidewalk, unclean condition, obstructions in the sidewalk due to illegal occupancy on the sidewalk (shops, vendors, car parking), air pollution, unsafe walking conditions especially at intersections, lack of comfortable walking environment, aesthetical presence and so on. The poor walking conditions on the sidewalks are sometimes forcing the pedestrians to walk on the road which is increasing their chance of being involved in crashes with vehicles. So it has become important for the planner to find out alternative solutions to draw the attention of the pedestrians to the walkway. In this research, afford had been made to find out the factors that encourage the pedestrians to walk in the walkway and avoid motorized vehicles. Some greenery had been proposed for the study areas through image classification tool.

Image Analysis for the Identification Greenery in Jatrabari Area

Existing Area



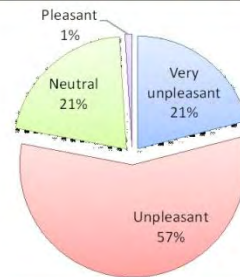
Proposed Green Area



Legend

Proposed Green Area

Value



Percentage (%) of Respondents for Street with Without Greenery (Jatrabari Area)

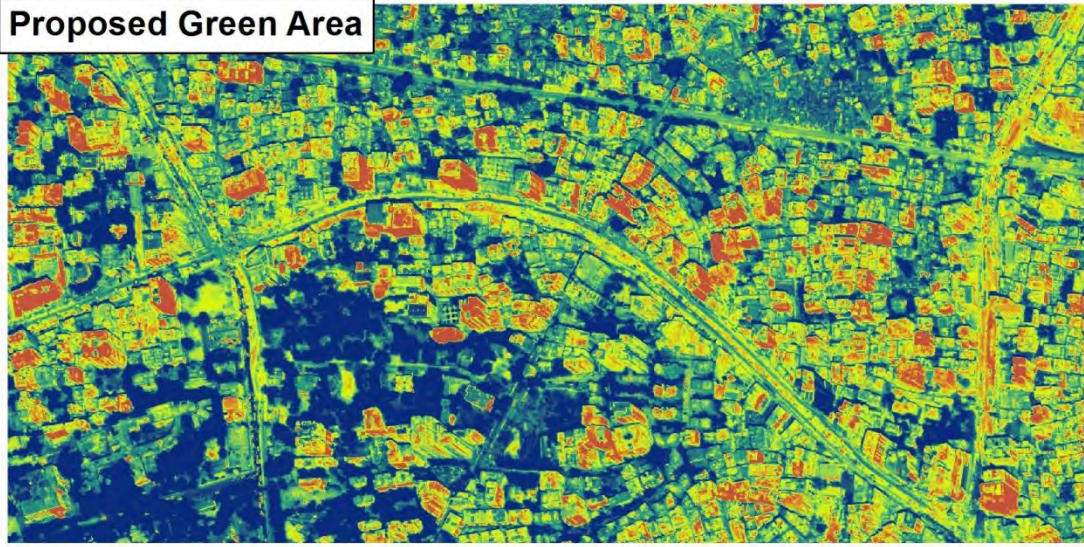
Fig 7.1: Proposed green area for Jatrabari area

Image Analysis for the Identification Greenery in Maghbazar Area

Existing Area



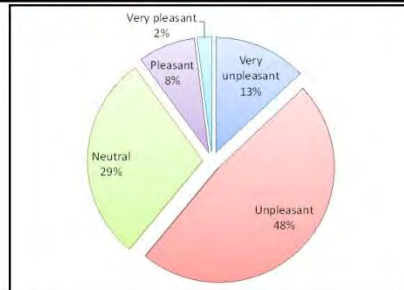
Proposed Green Area



Legend

Proposed Green Area

Value



Percentage (%) of Respondents for Street with Without Greenery (Maghbazar Area)

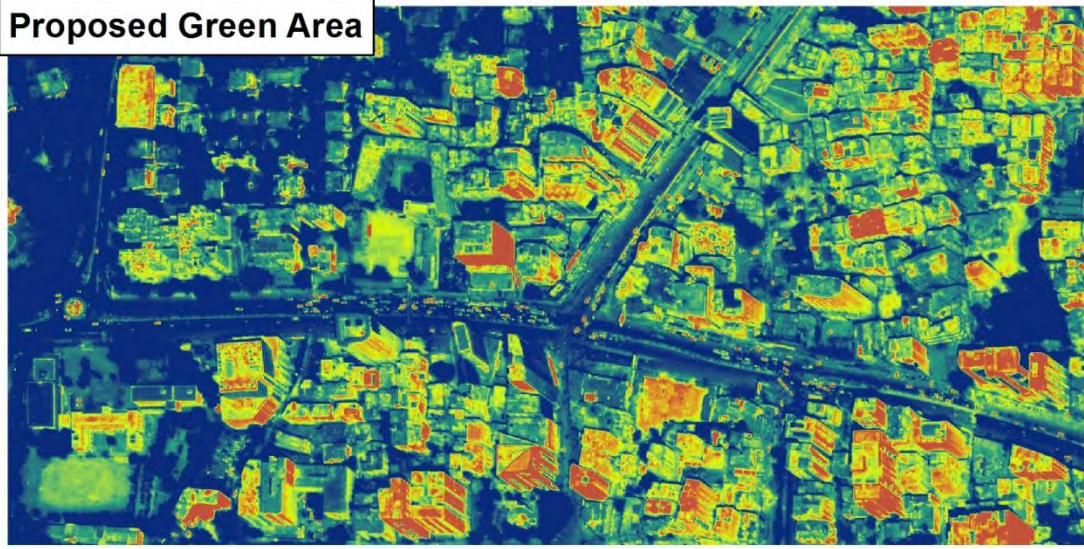
Fig 7.2: Proposed green area for Maghbazar area

Image Analysis for the Identification Greenery in Kakrail Area

Existing Area



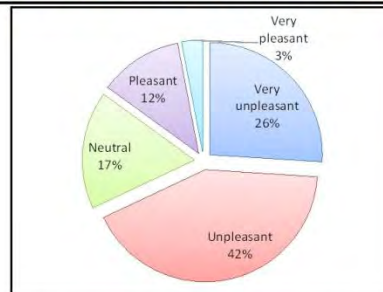
Proposed Green Area



Legend

Proposed Green Area

Value



Percentage (%) of Respondents for Street with Without Greenery (Kakrail Area)

Fig 7.3: Proposed green area for Kakrail area

Although this study focuses on improved landscape to promote pedestrians movement along the streets, it was also noticed that too many pedestrians and activities in particular streets can also bring negative impression for the street. While busy streets bring vitality in cities, in fact some pedestrians feel insecure because the street is too busy. This implies that there must be an optimum density in utilizing street spaces either for walking or other outdoor activities. For instance, while the street traders and groups of people sitting and talking in the sidewalks can stimulate social interactions on the street, in fact some pedestrians feel that they are obstructed from walking activities. When the street is overcrowded, comfortability of walking can be reduced.

Landscape elements and pedestrian movement are also spatially related. Through pedestrian volume count it was revealed that pedestrians prefer to walk in areas where landscape elements have been provided. This was more important especially during morning peak periods when the majority of the people were moving towards work places and evening peak periods when they were moving back home.

The findings from the study are summarized below:

- The pedestrians require quality walking space which should be environment friendly, comfortable and attractive so that pedestrians are being encouraged to walk within the walkway. In addition, sidewalks designed in an integrated way with greenery can provide pedestrians to walk with a healthy feeling of fresh air.
- Data on the following factors were collected through questionnaire survey and personal observation in the pedestrian walkways of the study areas: Presence of greenery, Climate condition, Aesthetic condition and Pedestrian volume. Simple statistical analysis was done to conduct the data analysis.
- For the research purpose five locations of Dhaka city were selected as study area. These are Jatrabari, Kakrail, Moghbazar, Manik Mia Avenue and pedestrian way along Ramna Park. Jatrabari, Kakrail, Moghbazar areas contain pedestrian walkways without greenery integrated walkway and Manik Miya Avenue and walkways around Ramna park fall under green oriented walkway but not optimized ones.

- The research is based on a questionnaire survey and an observation survey that had been developed at the very earlier stage. Those were considered as the main data-gathering instrument for this study.
- Among the respondents, almost 33% were service holders, 27% were students, 28% were businessmen and 12% were day labor. In Manik Miya Avenue and Kakrail area, school and college going students were dominant. In Jatrabari, Maghbazar and kakrail, businessmen and service holder number were higher than other areas.
- Street greenery has the ability to effectively reduce urban heat and improve thermal comfort on various scale levels. In streets with large tree crowns on both sides, as Manik Miya Avenue and Ramna Park area, the temperature had been captured 2⁰C lower than in streets without greenery as in Kakrail, Maghbazar and Jatrabari areas.
- 88% of the respondents answered that they prefer shaded walkway in a sunny and hot warm day. The rest 12% responds “No”. The respondents who answers negative, most were unable to understand the question or in a hurry.
- The majority of the respondents were willing to walk in the sun for a maximum time of 5-15 minutes, which holds for 70% of all respondents in selected three areas: Jatrabari, Maghbazar and kakrail, while their willingness to walk in the shade varies between 15-30 minutes to 45-60 minutes. 70 % of all respondents were interested to walk for 30-45 minutes in a shady walkway and 17.20% of respondents were willing to walk for maximum 60 minutes in greenery integrated area.
- 86% respondents were ready to walk for 15-30 minutes in a walkway without greenery. On the other hand, 78% of respondents were highly interested to walk for 30-45 minutes in a shady walkway. When the destination is work/school, the time that 57.40% of respondents are willing to walk in the shade is 30-45 minutes. Only 39.40% respondents were eager to walk for 30 minutes in a sunny walkway.
- In greenery integrated walkways, for abstract and specific destination, percentages of walking for 30 minutes for male and female are respectively

38.12% and 37.89%. This indicates that both male and female pedestrians like to walk in a shady and cool walkway.

- In sun exposure conditions, only 3.60% of female were willing to walk for 30 minutes and majority of 57.30% of female were expose their willingness to walk for only 5 minutes. On the other hand, in same climate condition, 48.19% of male pedestrians were willing to walk for 30 minutes. That means when the climate condition is bad, the percentage varies from male to female.
- Only 7.13% of young aged respondents were willing to walk in sun, if there is any emergency. 38.16% and 41.09% of the respondents respectively expressed their willingness to walk for 15 to 30 minutes in a sunny walkway. Walking time 45 to 60 minutes holds 0% share for 50 above people.
- 46.09% respondents of above 50 years said that they would walk in shade for highest 30 minutes. 57.10% and 49.99% respondents respectively aged 15-20 years and 21-25 years expressed their positive response to walk in shade. 40.82 % respondents of aged 26-30 years were willing to walk for 45-60 minutes in shade.
- Interview results indicated that people perceived thermal conditions in streets with greenery to be more comfortable than in streets without greenery, even though they were hardly aware of this positive influence of street greenery on their thermal comfort. Furthermore, people significantly valued the presence of greenery in aesthetic terms.

To alleviate traffic congestion and to move toward a sustainable built environment, expensive mass transit is not the only solution. Planners have realized that traffic congestion deteriorates the standard of living. To provide a quality standard of living, cities need to be designed for the people like in the traditional city form rather than for vehicles. In many countries planners are now focusing on pedestrian-friendly cities by designing the right of way to provide priority to the people. Cities such as Bogota has demonstrated that building continuous networks of sidewalks and bike lanes costs much less than a mass rapid transit, but has the ability to improve the living standard in the city. The main benefit of turning Dhaka into a pedestrian-friendly city is that, it will not require a huge financial investment and also will not require such long time to implement

yet it has the capability to improve traffic congestion, improve air quality, provide more equitable access and mobility and most importantly provide a sustainable built environment. This solution will be economically viable, equitable, and environmentally friendly, provide a healthy and vibrant community and most importantly, improve the standard of living of the city-dwellers.

7.2 Recommendation

Comfortable walkway is an increasing demand now a day in Dhaka city. With the increasing activities of people, pedestrian trips are also increasing. Without adequate walkway facilities, people will increasingly depend on motorized vehicles and more traffic will add more time in travelling.

Trees as shading elements are very important to urban design. One important impact of street trees on citizens is the reduction of thermal stress during hot meteorological background conditions. The use of significant tree coverage results in improved thermal comfort in urban spaces to encourage day time use. Inexpensive improvements, such as protecting a site from sun angles, can have a cooling impact to a space at a relatively low cost. Improving or protecting a site from hotter air Clusters of trees are ideal for providing pedestrian and open space shade to facilitate comfortable pedestrian circulation and outdoor seating areas. For example, palm trees cast long shadows and are very useful for providing pedestrian shade when grouped together, but they must be used thoughtfully due to their long shadow, flowing in can also reduce the overall intensity of the heat in a space.

From the field survey, data analysis and literature review in this study, following recommendations can be drawn for a better pedestrian way planning in Dhaka city:

- Landscape elements which consist of soft and hard elements include plant materials such as trees, flowers, shrubs, grasses, pavement, street furniture and fixtures promote walking by providing shade. These elements should be incorporated in the landscape of walkway to make walking comfortable and pleasant.

- Along walkways of continuous open space systems, hard and soft landscape elements should be provided with a view to promoting pedestrian movement. Tree nursery could be established so as to have reliable supply of seedlings for shading trees and hedges for the city.
- Attractive and user friendly footpath facility must be ensuring by eliminating retailer traders and hawker gradually. Besides this, it should be geometrically and aesthetically improved for increasing attraction and comfort, as pedestrians are encouraged to use footpath in lieu of carriage way.
- Installation of pedestrian fencing in terms of roadside greenery on the approaches and departures from signalized and other pedestrian facilities can encourage pedestrians to cross at these devices, rather than in the nearby zones of high risk.
- Natural environmental conditions, such as heat, rain and humidity, also influence pedestrian activities. Thus, impact of micro climate should be taken into account during planning of pedestrian areas and walkways. Shading of walkways by physical structures and trees as well as lighting provision during nighttime has an effect on pedestrian behavior.
- Choosing of trees for pedestrian way shading should be carefully. Trees reduce solar access in the summer and thereby effectively lower the thermal discomfort within their vicinity. While it is sufficient to provide shadowy places along the route of pedestrians in order to increase their thermal comfort, places where people stay over a prolonged period of time, like market places or playgrounds, have to be shaded large-scale.
- Haphazard parking on road side, illegal use of footpath like garage, building material should be eradicated.
- Maintenance of walkway environment is also very important. Regular follow up and care can ensure a healthy environment to the pedestrians.

Conclusion:

Urbanization has altered the natural landscape and affected the environmental cycle. Sidewalks and walkways should provide a continuous system of safe, comfortable and accessible pathways for pedestrians. Decisions on whether to provide a sidewalk should not be based on existing pedestrian volumes because they are not a reliable indication of pedestrian demand. Individuals tend to walk in locations where continuous connections are provided with an aesthetical and pleasant walkway. A lack of pedestrian activity in a location with uncomfortable sidewalks is, therefore, not necessarily an indication of a lack of pedestrian demand [28]. Covered walkways and canopies extending from buildings can also be used to shade and cool pedestrians. These design elements reduce the amount of direct sun, thus improving thermal comfort and reducing sun exposure, which can improve the ambient air temperature by up to 15%. Increasing the cover of trees in an urban environment is a simple and effective way to improve thermal comfort. Safety and comfort in the roadway environment is largely dependent on the width and quality of the buffer between the sidewalk and the roadway. Physical barriers between the sidewalk and roadway (such as street trees, landscaping, bike lanes and parked cars) increase pedestrian safety and comfort, and therefore encourage higher levels of walking [28]. Many cities in the western world are moving towards a pedestrian-friendly city. To increase the share of walking, besides building infrastructure facilities for walking, another important aspect, which is globally proved, that is necessary is to make pedestrian way so attractive to the pedestrian that they will prefer walking more than riding. Referring to the United Nations Centre for Human Settlements (UNHCS) forecast that Dhaka will be the sixth most populous city of the world by 2010 and second by 2015. Dhaka City Corporation has 390 kilometers long footpath while it has 1900 kilometers long roads including arterial roads, alleys and lanes [29]. Unfortunately no such study was conducted in Dhaka City which elaborated the behavior and preferences of pedestrian in choosing walkway for a particular place. So to manage this huge crowd, planners should have thought of the better walkway to slow down the boot of motorized vehicles. Each day people waste hours stuck in a gridlock during the rush hours. Apart from the time and energy lost in traffic, there is also the anxiety associated with arriving

late for an important appointment. Lack of pedestrian-friendly policies, poor planning and design of pavements and foot bridges are forcing large numbers of people to use roads. Travel choices are highly influenced by urban planning because the city spatial structure is somehow influenced by planning. So this is the time to re-think of the pedestrian way planning and renovate the existing walkway for the pedestrians.

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Bangladesh University of Engineering and Technology

Department of Urban and Regional Planning

Questionnaire Survey

1. Demographic information:

a) Name:

b) Gender: a) Male b) Female

c) Marital Status: a) Married b) Single

c) Age:

15-20 yrs	
21-25 yrs	
26-30 yrs	
31-40 yrs	
41-50 yrs	
51-60 yrs	
61 and above	

2. Employment information:

A) Occupation: a) Service holder b) Business c) Unemployed d) Student e) Retired

B) Monthly Income:

Tk 15000- tk 25000	
Tk 26000- tk 35000	
Tk 36000- tk 45000	
Tk 46000 and above	

4. Trip description

Origin	Destination	Purpose	Walking time	Frequency (in day)

5. Does greenery has any impact on your walking?

- a) Yes b) No

6. Why would you choose a shady walk way?

- a) Weather is comfortable.
- b) Shady walkway
- c) Better air flow
- d) Aesthetically pleasant

7. a) What would be your highest walking duration? (With greenery)

5 min	
15 min	
30 min	
60 min	
90 min	

b) What would be your highest walking duration? (Without greenery)

5 min	
15 min	
30 min	
60 min	
90 min	

8. Do you think a greenery integrated walkway is aesthetically pleasant?

- a) Yes b) No

Field Survey

1. Walkway width
 - a) With greenery-
 - b) Without greenery-
2. Walking barriers or visual obstacles
 - a)
 - b)
 - c)
 - d)
3. Walkway condition
 - a) Smooth and level
 - b) Cracks
 - c) Holes
 - d) Breakages
 - e) Rocky
4. Type of Sidewalk Pavement
 - a) Occupied
 - b) Non-occupied
5. Presence of greenery
 - a) Yes
 - b) No
6. Type of trees
 - a) Small
 - b) Large
 - c) Medium

Weather condition

7. Shade
 - a) Yes
 - b) No
8. Air temperature(Average Temperature)
 - a) With greenery-
 - b) Without greenery-
9. Surface temperature(Average Temperature)
 - c) With greenery-
 - d) Without greenery-
10. Humidity (in %) (average)
 - a) With greenery-
 - b) Without greenery-

11. Air flow

a) Yes

b) No

13. Air speed (average)

a) With greenery-

b) Without greenery

12. Scenic beauty

a) Yes

b) No

Gender	Marital Sta	Age	Occupation	Monthly in	Origin	Destination	Purpose	Walking tir	Frequency	Impact of g	Cause of choosing shady walk way				alking dura	alking dura	etetical plea
											Cool Weat	Shady Wal	Better Flov	Aesthetica			
Male	Married	D	Service	A	Mohamma	Tejgoan	Job	30	2	YES	1	1		1	30	15	YES
Male	Married	E	Service	B	Mohamma	Khamarbar	Job	20	2	YES		1	1		20	15	YES
Male	Unmarried	A	Student	-	Lalmatia	Indira road	Study purp	20	2	YES	1	1	1	1	15	15	YES
Female	Unmarried	B	Service	A	Asad Avn	Shangsad B	Hangout	10	1	YES		1			15	15	YES
Male	Married	C	Student	-	Dhanmond	Shangsad B	Job	30	2	YES		1		1	20	15	YES
Female	Unmarried	A	Student	-	Purbo Raza	Dhanmond	Study purp	20	1	YES	1	1	1	1	60	5	YES
Female	Married	E	Service	A	Agargaon	Shangsad B	Job	30	2	YES	1	1	1		30	30	YES
Male	Unmarried	B	Student	-	Mohamma	Monipurip	Study purp	30	2	YES		1	1		60	30	YES
Male	Married	F		-	Mohamma	Farmgate	Walking	30	2	YES	1	1		1	30	15	YES
Male	Married	E	Service	C	Lalmatia	Farmgate	Job	30	1	YES		1	1		60	30	YES
Female	Married	D	Service	D	Asad Avn	Farmgate	job	30	1	YES		1		1	30	30	YES
Male	Married	B	Service	A	Razabazar	Mohamma	Hangout	30	1	YES	1	1	1		15	5	YES
Male	Unmarried	B	Student	-	Monipurip	Asad Avn	Study purp	30	2	YES		1	1	1	60	30	YES
Female	Married	B	Student	-	Asad Avn	Farmgate	Study purp	30	2	YES	1	1	1		60	60	YES
Female	Unmarried	C	Student	-	Lalmatia	Monipurip	Study purp	30	2	YES		1			30	30	YES
Male	Married	C	Service	A	Mohamma	Khamarbar	Walking	30	2	YES		1		1	30	30	YES
Male	Unmarried	C	Student	-	Dhanmond	Farmgate	Study purp	30	1	YES	1	1	1	1	30	15	YES
Male	Unmarried	D	Bussiness	C	Khamarbar	Mohamma	Walking	30	2	YES	1	1			30	30	YES
Male	Unmarried	E	Bussiness	D	Monipurip	Dhanmond	Walking	30	2	YES		1	1	1	30	15	YES

AGE	
A	15-20
B	21-25
C	26-30
D	31-40
E	41-50
F	51-60

Income	
A	15000-25000
B	26000-35000
C	36000-45000
D	46000- more

Pedesterian		
Off Day	724	per hour
On Day	1375	per hour

Gender	Marital Status	Age	Occupation	Monthly income	Origin	Destination	Purpose	Walking time	Frequency(in day)	Impact of greenery on	Cause of choosing shady walk way				Highest walking duration(WG)	Highest walking duration	Aesthetical pleasance
											Cool Weather	Shady Walkway	Better Flow	Aesthetically Pleasant			
Male	Married	E	Service	B	Highcourt	Ramna	Walking	25	1	YES	1	1			30	15	YES
Male	Unmarried	A	Service	B	Shabagh	Ramna	Job	20	2	YES		1	1	1	20	15	YES
Male	Married	D	Student	-	Kakrail	Shahbagh	Study purpose	20	2	YES	1	1	1		15	15	YES
Male	Married	B	Service	A	Segunbagicha	DU	Walking	10	2	YES	1	1			15	15	YES
Female	Married	C	Student	-	DU	Kakrail	Job	30	2	YES		1		1	20	15	YES
Male	Unmarried	A	Student	-	Baily road	Ramna	Study purpose	20	2	YES		1	1		60	5	YES
Male	Married	E	Service	A	Shabagh	Kakrail	Job	30	2	YES	1	1			30	30	YES
Female	Married	B	Bussiness	C	Shabagh	Matsho bhaban	Walking	25	1	YES		1	1	1	60	30	YES
Male	Unmarried	A	Student	-	Ramna	Baily road	Walking	20	1	YES	1			1	30	15	YES
Female	Married	E	Service	C	Shabagh	Ramna	Job	30	2	YES	1	1	1		60	30	YES
Male	Married	D	Service	B	Katabon	Ramna	job	30	1	YES		1		1	30	30	YES
Male	Married	B	Service	A	Segunbagicha	Shabagh	Job	25	1	YES	1	1	1		15	5	YES
Male	Unmarried	A	Student	-	DU	Kakrail	Study purpose	20	2	YES		1		1	60	30	YES
Male	Married	E	Bussiness	B	Baily road	Shahbagh	Study purpose	30	2	YES	1		1	1	60	60	YES
Female	Unmarried	A	Student	-	Shabagh	Kakrail	Study purpose	30	1	YES		1	1		30	30	YES
Male	Married	C	Service	A	DU	Baily road	Walking	25	2	YES		1		1	30	30	YES
Female	Unmarried	A	Student	-	Shabagh	Segunbagicha	Study purpose	30	2	YES	1	1	1		30	15	YES
Male	Married	D	Service	C	Ramna	Shahbagh	Walking	30	1	YES	1	1		1	30	30	YES
Male	Unmarried	A	Bussiness	B	Shabagh	Ramna	Walking	20	1	YES		1	1	1	30	15	YES

AGE	
A	15-20
B	21-25
C	26-30
D	31-40
E	41-50
F	51-60
Income	
A	15000-25000
B	26000-35000
C	36000-45000
D	46000- more

Pedesterian		
Off Day	401	per hour
On Day	967	per hour

Gender	Marital Status	Age	Occupation	Monthly income	Origin	Destination	Purpose	Walking time	Frequency(in day)	Impact of greenery on walking	Cause of choosing shady walk way				Highest walking duration(WG)	Highest walking duration (WOG)	Aesthetical pleasance
											Cool Weather	Shady Walkway	Better Flow	Aesthetically Pleasant			
Male	Married	C	Service	A	Old Eskaton	Maghbazar	Walking	10	2	YES	1	1		1	30	5	YES
Female	Married	E	Service	B	Old Eskaton	Mouchak	Job	13	2	YES	1	1	1	1	20	15	YES
Male	Married	A	Student	-	Bara Maghbazar	Mouchak	Study purpose	10	2	YES	1	1	1		30	20	YES
Female	Unmarried	B	Service	A	Mouchak	Old Eskaton	Hangout	10	1	YES		1	1	1	20	15	YES
Male	Married	C	Student	-	Siddeshwari	Hatirjhil	Job	16	2	YES		1	1		20	20	YES
Male	Unmarried	A	Student	-	New Eskaton	Old Eskaton	Study purpose	14	1	YES		1	1	1	30	60	YES
Male	Married	E	Service	A	New Eskaton	Maghbazar	Job	13	2	YES	1	1		1	20	20	YES
Female	Married	B	Student	-	Old Eskaton	New Eskaton	Study purpose	12	1	YES		1	1		30	30	YES
Male	Married	F	Retired	-	New Eskaton	Mouchak	Walking	12	1	YES	1	1		1	20	15	YES
Male	Married	E	Service	C	New Eskaton	Mouchak	Job	15	1	YES	1	1	1		20	20	YES
Male	Married	D	Service	D	Old Eskaton	Bara Maghbazar	job	14	1	YES		1	1	1	30	30	YES
Female	Married	B	Service	A	Siddeshwari	Bara Maghbazar	Hangout	10	2	YES		1		1	15	30	YES
Male	Unmarried	B	Student	-	Maghbazar	New Eskaton	Study purpose	10	2	YES		1			30	30	YES
Male	Married	B	Student	-	Maghbazar	New Eskaton	Study purpose	10	2	YES	1	1	1		30	20	YES
Male	Unmarried	C	Student	-	Old Eskaton	Mouchak	Study purpose	13	2	YES		1		1	20	30	YES
Female	Married	C	Service	A	Maghbazar	New Eskaton	Walking	13	3	YES	1	1	1		30	30	YES
Male	Married	C	Student	-	Mouchak	Bara Maghbazar	Study purpose	12	1	YES	1	1	1	1	15	20	YES
Male	Unmarried	D	Bussiness	C	Maghbazar	Eskaton Garden		12	2	YES	1	1			20	30	YES
Female	Married	E	Bussiness	D	Mouchak	New Eskaton	Walking	15	2	YES	1	1	1	1	30	20	YES

AGE	
A	15-20
B	21-25
C	26-30
D	31-40
E	41-50
F	51-60
Income	
A	15000-25000
B	26000-35000
C	36000-45000
D	46000- more

Pedesterian		
Off Day	821	per hour
On Day	1419	per hour

Gender	Marital Sta	Age	Occupation	Monthly in	Origin	Destination	Purpose	Walking	Freque	Impact	Cause of choosing shady walk way				alking dur	alking dur	metical plea
											Cool Weat	Shady Wal	Better Flov	Aesthetica			
Male	Married	E	Service	B	Ramna	New Paltar	Job	20	2	YES	1	1	1	1	20	15	YES
Female	Married	D	Service	A	Baily Road	New Paltar	Hangout	20	1	YES		1	1		15	5	YES
Male	Unmarried	A	Student	-	Bijoy Nagar	Ramna	Study purp	15	3	YES	1	1			20	15	YES
Female	Unmarried	D	Service	A	Baily Road	New Paltar	Hangout	20	1	YES		1	1	1	15	5	YES
Male	Married	C	Student	-	Baily Road	Ramna	Walking	10	2	YES	1	1		1	30	15	YES
Female	Unmarried	A	Student	-	Bijoy Nagar	Baily Road	Study purp	10	2	YES	1	1	1	1	60	5	YES
Female	Married	E	Service	B	Santinagar	Ramna	Job	10	1	YES		1		1	20	5	YES
Male	Unmarried	B	Student	-	Santinagar	Bijoy Nagar	Study purp	20	1	YES		1	1	1	30	30	YES
Female	Married	D	Jnemloyee	-	New Paltan	Ramna	Walking	30	1	YES	1	1	1	1	20	15	YES
Male	Married	E	Service	C	New Paltan	Baily Road	Job	20	2	YES		1	1	1	30	15	YES
Female	Married	D	Service	B	Santinagar	Bijoy Nagar	job	30	1	YES		1			30	30	YES
Male	Married	B	Service	A	Ramna	Santinagar	Hangout	20	2	YES	1	1	1		30	5	YES
Male	Unmarried	C	Student	-	Bijoy Nagar	Baily Road	Study purp	30	2	YES	1	1		1	30	15	YES
Female	Married	D	Service	B	Baily Road	Ramna	Walking	30	1	YES	1	1	1		60	30	YES
Female	Unmarried	C	Student	-	Santinagar	New Paltar	Study purp	30	1	YES	1	1			20	30	YES
Male	Married	C	Service	A	Ramna	Santinagar	Job	20	2	YES	1	1	1	1	30	30	YES
Male	Unmarried	C	Student	-	New Paltan	Ramna	Study purp	20	1	YES		1	1	1	20	15	YES
Female	Married	D	Bussiness	C	Baily Road	Bijoy Nagar	Job	10	2	YES		1	1	1	30	30	YES
Male	Married	E	Bussiness	D	Ramna	Baily Road	Walking	10	1	YES	1	1	1	1	20	15	YES

AGE	
A	15-20
B	21-25
C	26-30
D	31-40
E	41-50
F	51-60
Income	
A	15000-25000
B	26000-35000
C	36000-45000
D	46000- more

Pedesterian		
Off Day	833	per hour
On Day	1017	per hour

Gender	Marital Sta	Age	Occupation	Monthly in	Origin	Destination	Purpose	Walking tir	Freque	Impact o	Cause of choosing shady walk way				alking dura	alking dura	netical plea
											Cool Weat	Shady Wal	Better Flov	Aesthetica			
Male	Unmarried	A	Student	-	lpur New r	abad Bus st	Study purp	5	4	YES		1	1	1	15	15	YES
Male	Unmarried	A	Student	-	Koratola	lpur New R	Study purp	7	1	YES		1	1		20	30	YES
Male	Unmarried	A	Student	-	Koratola	lpur New R	Study purp	7	1	YES		1	1	1	15	30	YES
Male	Unmarried	B	Student	-	Koratola	lpur New R	Study purp	5	1	YES	1	1			15	15	YES
Male	Married	E	Service	D	abas Bus St	lpur New R	Job	6	2	YES	1	1		1	30	30	YES
Female	Unmarried	A	Student	-	orth Jatraba	aidabad Bu	Walking	10	2	YES	1	1	1	1	60	5	YES
Female	Married	E	Service	D	orth Jatraba	Saidabad	Job	5	2	YES	1	1			20	15	YES
Male	Unmarried	B	Student	-	lpur New r	Saidabad	Study purp	7	2	YES		1			60	30	YES
Female	Unmarried	B	Student	-	lpur New r	Saidabad	Walking	7	1	YES		1		1	30	15	YES
Male	Unmarried	C	Student	-	orth Jatraba	Saidabad	Study purp	7	1	YES	1	1	1		60	30	YES
Female	Married	D	Service	D	Koratola	orth Jatraba	job	9	2	YES		1		1	30	20	YES
Male	Married	D	Service	D	Koratola	orth Jatraba	Job	7	2	YES	1	1	1		15	5	YES
Male	Unmarried	B	Student	-	Koratola	orth Jatraba	Study purp	6	2	YES	1	1	1	1	60	30	YES
Female	Unmarried	F	Service	C	orth Jatraba	Koratola	Job	7	2	YES	1	1	1		30	60	YES
Female	Unmarried	C	Student	-	orth Jatraba	Koratola	Study purp	7	4	YES		1	1		60	30	YES
Male	Married	E	Service	B	lpur New r	nchim Jatra	Walking	6	3	YES	1	1	1	1	30	30	YES
Male	Unmarried	B	Student	-	lpur New r	Koratola	Study purp	6	2	YES	1	1		1	60	15	YES
Male	Unmarried	D	Bussiness	C	lpur New r	Koratola	Walking	7	2	YES	1	1			30	30	YES
Male	Unmarried	E	Bussiness	D	orth Jatraba	nchim Jatra	Walking	5	2	YES	1	1	1	1	60	15	YES
Male	Married	D	Bussiness	D	orth Jatraba	orth Jatraba	Walking	5	2	YES	1	1	1	1	30	20	YES
Male	Unmarried	D	Service	C	nchim Jatra	Saidabad	Walking	7	1	YES		1	1		30	20	YES
Female	Married	D	Service	D	orth Jatraba	Koratola	Walking	7	1	YES	1	1		1	30	30	YES
Male	Unmarried	B	Student	-	lpur New r	Koratola	Study purp	6	2	YES	1	1	1	1	60	20	YES

AGE	
A	15-20
B	21-25
C	26-30
D	31-40
E	41-50
F	51-60
Income	
A	15000-25000
B	26000-35000
C	36000-45000
D	46000- more

Pedesterian		
Off Day	1335	per hour
On Day	1428	per hour

Gender	Marital Status	Age	Occupation	Monthly income	Origin	Destination	Purpose	Walking time	Frequency(in day)	Impact of greenery on walking	Cause of choosing shady walk way				Highest walking duration(Highest walking duration	Aesthetical pleasance
											Cool Weather	Shady Walkway	Better Flow	Aesthetically Pleasant			
Male	Married	D	Service	A	Mohammadpur	Tejgoan	Job	15	2	YES	1	1		1	30	15	YES
Male	Married	E	Service	B	Mohammadpur	Khamarbari	Job	15	2	YES		1	1		20	15	YES
Male	Unmarried	A	Student	-	Lalmatia	Indira road	Study purpose	20	2	YES	1	1	1	1	15	15	YES
Female	Unmarried	B	Service	A	Asad Avn	Shangsad Bhaban	Recreation	10	1	YES		1			15	15	YES
Male	Married	C	Student	-	Dhanmondi	Shangsad Bhaban	Job	20	2	YES		1		1	20	15	YES
Female	Unmarried	A	Student	-	Purbo Razabazar	Dhanmondi	Study purpose	20	1	YES	1	1	1	1	60	5	YES
Female	Married	E	Service	A	Agargaon	Shangsad Bhaban	Job	15	2	YES	1	1	1		30	30	YES
Male	Unmarried	B	Student	-	Mohammadpur	Monipuripara	Study purpose	20	2	YES		1	1		60	30	YES
Male	Married	F	Service	-	Mohammadpur	Farmgate	Recreation	30	2	YES	1	1		1	30	15	YES
Male	Married	E	Service	C	Lalmatia	Farmgate	Job	30	1	YES		1	1		60	30	YES
Female	Married	D	Service	D	Asad Avn	Farmgate	job	30	1	YES		1		1	30	30	YES
Male	Married	B	Service	A	Razabazar	Mohammadpur	Recreation	30	1	YES	1	1	1		15	5	YES
Male	Unmarried	B	Student	-	Monipuripara	Asad Avn	Study purpose	30	2	YES		1	1	1	60	30	YES
Female	Married	B	Student	-	Asad Avn	Farmgate	Study purpose	30	2	YES	1	1	1		60	60	YES
Female	Unmarried	C	Student	-	Lalmatia	Monipuripara	Study purpose	30	2	YES		1			30	30	YES
Male	Married	C	Service	A	Mohammadpur	Khamarbari	Recreation	30	2	YES		1		1	30	30	YES
Male	Unmarried	C	Student	-	Dhanmondi	Farmgate	Study purpose	30	1	YES	1	1	1	1	30	15	YES
Male	Unmarried	D	Bussiness	C	Khamarbari	Mohammadpur	Recreation	30	2	YES	1	1			30	30	YES
Male	Unmarried	E	Bussiness	D	Monipuripara	Dhanmondi	Recreation	30	2	YES		1	1	1	30	15	YES

AGE	
A	15-20
B	21-25
C	26-30
D	31-40
E	41-50
F	51-60

Income	
A	15000-25000
B	26000-35000
C	36000-45000
D	46000- more

Pedestrian		
Off Day	724	per hour
On Day	1375	per hour

Percentage of Pedestrian's Occupation			
Sl	Occupation	Number	Percentage
1	Service holder	8	40
2	Student	7	35
3	Business	2	10
4	others	3	15

Purpose of walking			
Sl	Purpose	Number	Percentage
1	Service		
2	Study		
3	recreation		
4	Business		
5	Others		