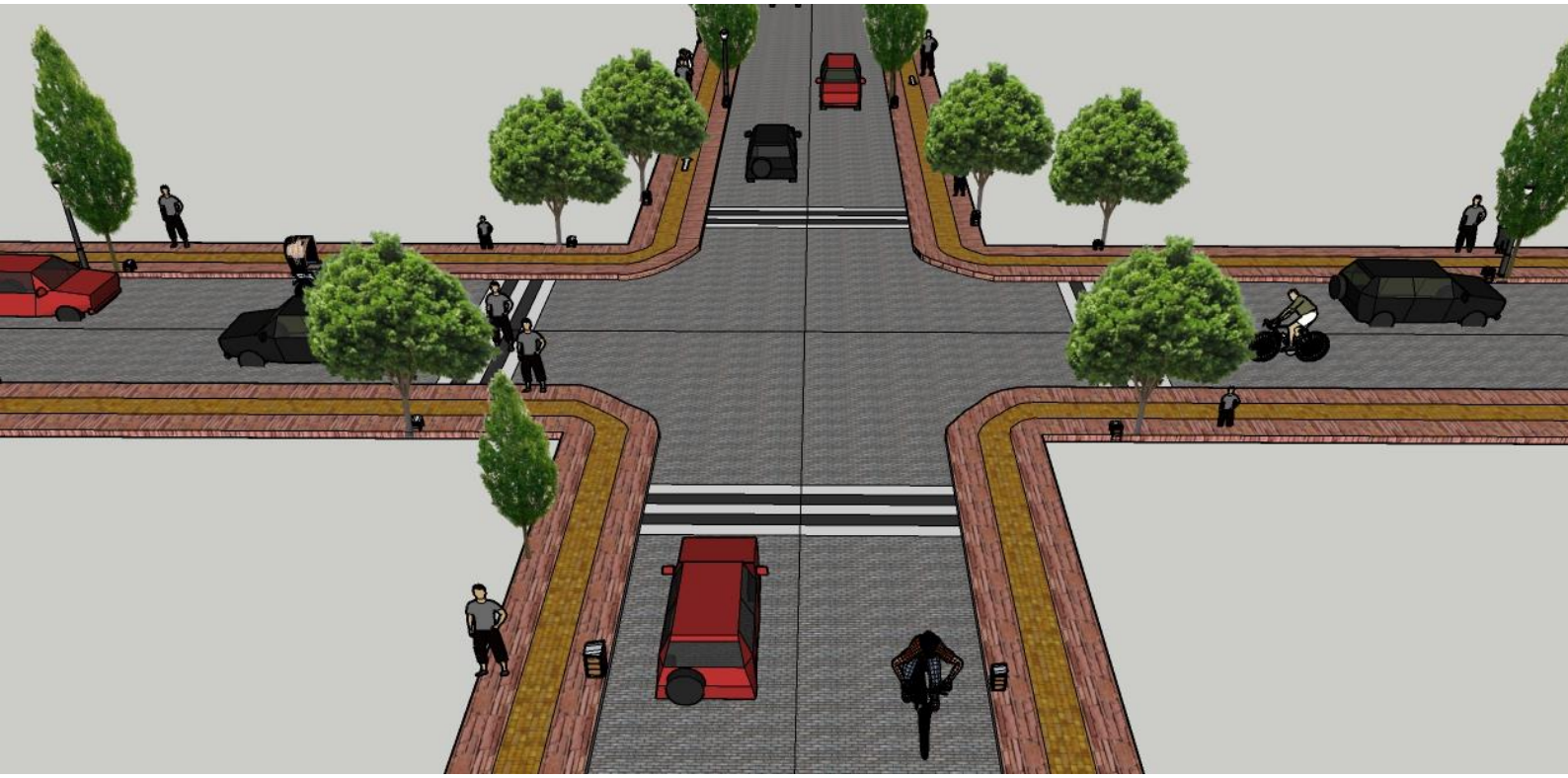
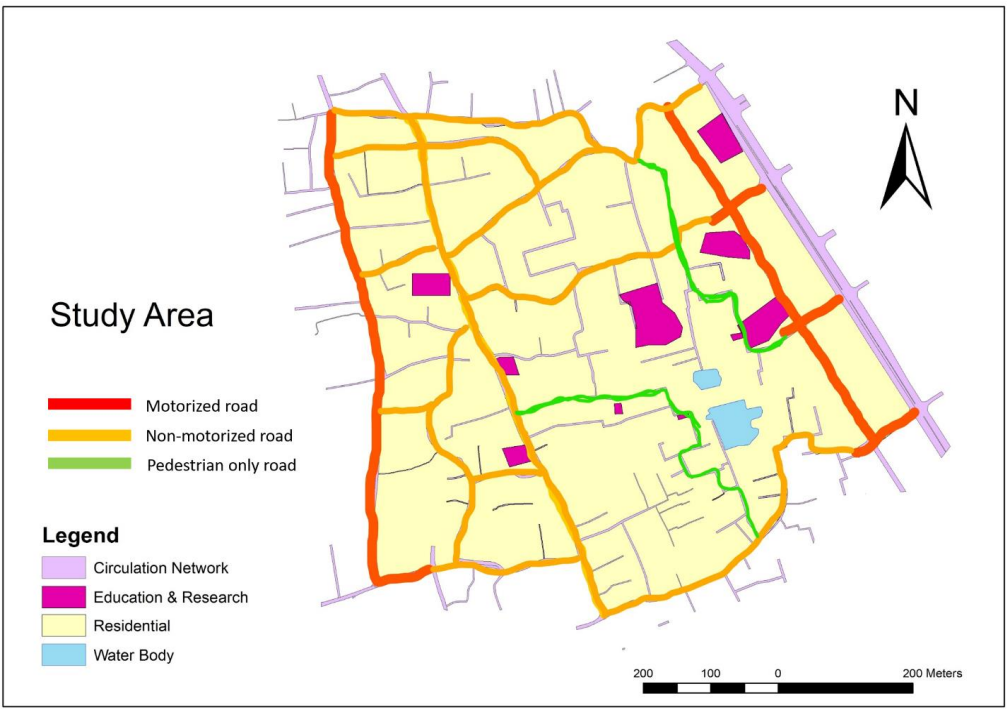
DESIGNING A SAFE, VIBRANT AND PEDESTRIAN FRIENDLY TRANSPORT FACILITIES: A STUDY IN RAYER BAZAR AREA, DHANMONDI, DHAKA





Designing a Safe, Vibrant and Pedestrian Friendly Transport Facilities: a Study in Rayer Bazar Area, Dhanmondi, Dhaka.

Submitted To:

Work for a Better Bangladesh (WBB) Trust.

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Abstract

Pedestrian friendly transportation is so much important for any local area as it increases the social gathering, improves the safety for children and women, and also improves the public health and overall environment. The study is to design a safe, vibrant and pedestrian friendly transport facilities which has three fold objectives. To conduct the study, Rayer bazar area of Dhanmondi is selected. The objectives of the study is to analyze the existing transport facilities, improve walkability through design guideline and improve circulation pattern of the study area. All the roads of the area are divided into 12 segments according to similar characteristics. Those roads are local road which connect a collective road (Dhanmondi Satmosjid road) in the area. Most of the road width is between 12-18 feet only. While only three segments have width more than 25 ft. All the roads are carrying two way motorize and non-motorize traffic. Eleven of the selected 12 segments has no footpath for pedestrian but pedestrian volume is so high for most of the roads. As the area has no arrangement for pedestrian walking so people comprised with school going children and women have no safety and security while they are walking. So, to solve all these problems and achieve the objectives of the study, pedestrian friendly transport facilities have high feasibility in the area. To fulfill the objectives, all the roads have been divided into four categories. Wide roads (width more than 25 ft.) is designed for motorize and non-motorize vehicle which has also footpath for pedestrian. Roads having width between 15 to 25 feet is designed for only non-motorize vehicle and pedestrian. Roads having width less than 15 feet is designed for only pedestrian use and vendors. Dead end roads are designed for pedestrian, social gathering, children playing etc. purpose. Those categorized roads would help to make the area pedestrian and environment friendly.

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Chapter 1: Introduction

1.1 Background of the Study

Walking is the oldest and most basic form of transportation. The following characteristics make walkable cities: 1. Coherence 2. Continuity 3. Equilibrium 4. Safety 5. Comfort 6. Sociability 7. Accessibility 8. Efficiency 9. Attractiveness etc. (Riham, n.d.). A walkable community is like people of all ages and abilities have easy access to their community "on foot", neighborhoods are safer, healthier, and friendlier places, parents feel comfortable about their children being outside in their neighborhoods, children spend more time outside with other children and are more active, physically fit, and healthy etc. (MARC, 1998). Walkable neighborhoods have the ability to encourage more social interaction and greater community involvement, which in turn leads to greater social capital within the community. Social capital has been defined as "the social networks and interactions that inspire trust and reciprocity among citizens" (Leyden 2003). Walking for transport decreases the number of trips a person makes by car. This has the potential to reduce greenhouse gas emissions and therefore to increase air quality (Ewing et al. 2011).

Being the capital of Bangladesh, Dhaka has now been considered as the commercial hub of the country as well as the cultural, political Centre. Over the last 10 years, the population of Dhaka has more than doubled. But this growth has been occurred with limited space and resource; so the congestion has been increasing in an uncontrolled way harming the environment and public health as well. Developing infrastructure and unplanned transport facilities made on limited resources now creates haphazard and unsafe environment. In order to increase urban mobility to face the challenges now Dhaka faces inequality, unhealthy urban environment and unsafe streets for the pedestrians as well.

To remove the growing traffic problems, the authorities have been taking various initiatives like Mass Rapid Transit project, Bus Rapid Transit project, constructing flyovers etc. These projects also focus on the needs of the pedestrians. The purpose of transportation is to transfer people and products from one place to another instead of increasing vehicles on the roads. To maintain public health and environment both, it is now necessary to increase walkability and decrease automobile services as well. Walkability encourages citizens and visitors participate on walking. As walkability does not harm the physical environment, it is free, requires little amenities and no fuel is used as a result, it maintains the environment with the betterment of

public health as well. The form of walkability addresses cycling, rickshaws and other sustainable modes of accessible transportation networks (Debra, 2011).

Walkability for pedestrians is necessary as it develops the health of citizens and removes the chronic effect of inactive physical activities due to lack of opportunities. It addresses pedestrian's safety issues as pedestrians are the main victims of congested and busy traffic roads. Even for increasing learning capacity for children like "School going group" the noise pollution is a great obstacle. As to reduce this major issue and reducing the congestion for their smooth movement on road, it is necessary to encourage walking more instead of using heavy vehicles which requires more space than rickshaws or bicycles. Consequently, the space for people-friendly venues like parks, playgrounds, public spaces etc. are reducing day by day. While the roads are becoming narrower day by day for uprising buildings, garages and commercial uses, the tendency of public gathering is also reducing simultaneously. The connection among people has been loosening and livability becomes scarce. To ensure safety, public health, environmental vibrancy and overall pedestrian accessibility needs a user-friendly street with consideration of footpath width, street furniture, vendor facilities, road characteristics, circulation patterns, open spaces, drainage etc (Debra, 2011).

1.2 Objectives of the Study

Our goal is to design a safe, vibrant and pedestrian friendly transport facilities in the study area.

We have worked on three fold objectives.

- To study the existing condition of transport facilities in the study area.
- To improve walkability ensuring eco-friendly behavior in the study area.
- To improve transport circulation pattern in the area.

1.3 Scope of the Study

- This project would be able to design a pedestrian friendly footpath with proper street elements.
- It will ease the flow of traffic without hampering the pedestrians.
- It will ensure security to the pedestrians especially children and women and it may widen the scope of socialization.
- Proper management of hawkers can change the scenario of the area and can also be implement in other areas.

- This study may contribute in future to analyze the efficiency of the area.
- This research can be used for further research conducted in future.
- This design can be used as a replica for designing other area.

1.4 Limitation of the Study

- As the study area is precisely large, there was shortage of time and manpower.
- We have selected a small portion of the area. The study would have been much more extensive if we could analyze a large portion of the area.

CHAPTER 2: LITERATURE REVIEW

2.1 Studies from Abroad

Jan Gehi stated that: "A good city is like a good party. People don't want to leave early". Each of us does it every day as some part of every trip. At the same time, walking has generally received little or no attention in the planning, design, and development of our communities. This includes such things as land-use planning, zoning, subdivision and site-plan review, street and highway design etc. There are tremendous opportunities to improve conditions for walking and in so doing, to make the communities more livable (MARC, 1998).

Walkable neighborhoods have the ability to encourage more social interaction and greater community involvement, which in turn leads to greater social capital within the community. Social capital has been defined as "the social networks and interactions that inspire trust and reciprocity among citizens" (Leyden 2003). Walking for transport decreases the number of trips a person makes by car. This has the potential to reduce greenhouse gas emissions and therefore to increase air quality (Ewing et al. 2011). Having fewer cars on the road also leads to less polluted urban storm water runoff, and therefore to higher watershed health and water quality. Other environmental benefits of walking rather than driving include reduction of noise pollution, conservation of land, and alleviation of traffic congestion (Pucher and Dijkstra 2003). As walkability has become an ever more important issue in the fields of urban planning, public health, and transportation, researchers have been developing ways to evaluate it quantifiably. Many walkability audit tools now exist, but there is no consensus as to which tool is best for measuring walkability (Dannenberg and Wendel 2011).

Case study 1: Evolving Pedestrian Friendly Residential Neighborhood Layout.

Location: Aligarh, India.

Project description:

Indian cities are growing rapidly due to boost in production and sustained economic growth over the past decade. This has created wealth entailing increase in the consumer demands and leads to increasing vehicular volume in the cities. Increase in vehicular volume has created a chaotic situation on urban roads. This problem of traffic congestion has crept from the city main roads to collector streets and local streets. The residential areas having relatively less ROW are worst affected by increase in volume of vehicular traffic and off street parking. The

residential neighborhood roads are no longer safe for the pedestrian and children. So, the concept of a peaceful neighborhood with low vehicular traffic and pedestrian friendly circulation pattern lies in tatters (Rahman, 2012).

To procure a decent and peaceful living space and a healthy residential environment, these areas are supposed to be free from everyday hassles and conflicts of urban life. It should be friendly to the pedestrian movement. It is essential to evolve residential sector layouts to sort out the problems of urban traffic chaos. The paper aims to determine the following:

1. Restrict the vehicular movement in residential areas.

2. Local shopping areas to be segregated from the residential zone in the residential areas.

3. Discouraging thoroughfare in side residential areas.

4. Segregate vehicular and pedestrian traffic.

5. Avoiding conflict points and provision of pedestrian safety measures at conflict points.

6. Evolving pedestrian friendly, environment friendly and safe traffic movement inside the residential areas (Rahman, 2012).

Case study 2: A City for People

Location: Copenhagen (Denmark)

Copenhagen is internationally famous for its unique creation of lively pedestrian streets. Winding, relatively narrow streets with old, long streets define this area, producing a mysterious sensation from the tightness and towering buildings. 1962 was a big year for Stroget, since its main shopping streets began to convert into a pedestrian promenade. About 96,000 square meters were designated for pedestrian spaces, where cars were permitted to pass through, only at low speeds.

What makes the street unique to the human eye are the open, stopping squares for formal and informal entertainments and restaurants or coffee shops, along with food stalls and attractions (Ting, 2010).

Case study 3: Violation of Pavements

Location: Alexandria (Egypt)

Mainly, roads and streets are designated for vehicular transportation and pedestrian pathways outline their borders. This makes pedestrians secondary to automobiles. Sometimes, streets do not occupy sidewalks and pavements. Sidewalks neither regulate the movement of pedestrians nor provide them with comfort and ease of movement. The street is occupied with stalls of various kinds, barriers and obstacles and advertisements in various forms. There are no specifications or standards to respect the pavement or sidewalk display materials, construction and real estate. It is worth mentioning that all such violations are due to lack of professionals (Riham, n.d.).

2.2 National Study

Case Study 4: Accommodating the Pedestrians and Bicyclists in the Neighborhoods of Dhaka: An Investigation of Existing Situation.

Location: Dhaka, Bangladesh

Project Description:

To keep a healthy and eco-friendly environment for the city dwellers, it is important to ensure a well-planned strategy for all development projects. As Dhaka is the mega city of Bangladesh, all the people are attracted to this commercial hub and consequently this city's population is increasing in an uncontrolled way. To conduct this research for encouraging the walkability for pedestrians and cyclists, this study's first theme was to investigate the existing situation of the streets. The study areas were a planned residential area- Dhanmondi and an unplanned residential area-Kalabagan.

Dhanmondi was found with ill designed and ill patterned walkways with grid iron pattern while Kalabagan had no walkways along with its organic pattern. After surveys, it was found that around 45% residents of Dhanmondi and 81% residents of Kalabagan were interested for bicycling. But the actual scenario was found that in Dhanmondi 9.5% people and in Kalabagan 22% people could actually attain it. After collecting all the data about the reasons behind this obstacle along with residents' demand, their views and ideas towards a social, active, liveable and safe pedestrian walkways; recommendations were made to encourage pedestrians and bicyclists in that current transport network (Taslim I. A., 2005).

Chapter 3: Methodology of the Study

Methodology means the strategy of conducting a research that outlines the way in which a research project is to be started, conducted and conclude. For a successful research methodology is one of the key issues. The following methodology has been adopted to fulfill the objectives of our study.

1. **Project Initiation:** At first, the project has been initiated by WBB Trust to developing a pedestrian friendly transport facility in Dhanmondi area. Then after discussion, title of the project has been defined as 'Designing a safe, vibrant and pedestrian friendly transport facilities: A study on Rayer Bazar Area.
2. **Formulation of Aim and objectives:** Objectives contribute a lot to conduct any study in a systematic way. Objective is what are we want to reach or achieve in concrete terms within a specified time, in order to contribute towards achieving the final aim. They are like guidelines that help to form the complete structure of the study. To complete the project relevant aim has been selected and then relevant objectives have been formulated which satisfy the project aim considering scopes and limitations.
3. **Review of Relevant Studies and Policies:** Relevant literature such as national and international policies, laws and acts, studies from Bangladesh and abroad etc. regarding project have been reviewed. Strategies or policies from both Bangladesh and abroad (STP, DMDP, DAP etc.) and other studies based on performance assessments of footpath design with necessary vendor management and others, will be reviewed and some tools and techniques would be used which have been seemed to be relevant and efficient for this study. For better understanding of the project, relevant projects, research reports, documents, thesis reports, newspapers and policies from abroad will be reviewed.
4. **Selection of the study area:** After formulating goal and objectives and reviewing relevant studies from abroad and national case, a suitable study area has been selected to conduct the study.
5. **Preparation of variables**

   Some variables were prepared regarding to fulfil the objectives of the study. The variables consisted of the existing condition of transport facilities, land use, volume of traffic, environment condition etc.

6. **Preparation of co-ordination schema**

   A co-ordination schema is prepared showing the data to be collected and analyzed to carry out the relevant objectives. Data collection method was also shown there.

7. **Preparation of checklist and reconnaissance survey:** A checklist has been prepared to analyze the physical attributes of the area. A pilot survey is necessary to realize the present condition of study route and check the feasibility whether this area is justified for the project or not.

8. **Collection of data:** Data collection from both primary and secondary sources is needed for this project. From secondary sources, data on government policies, acts, laws, relevant projects and researches, demographic and socio-economic profile of study area has been collected. Primary data has been collected through various surveys such as questionnaire survey, Physical Feature Survey, transport survey etc. Data of existing condition of transport facilities and circulation pattern is collected through these survey. Traffic volume data is collected through volume survey.

9. **Data processing and analysis:** All data collected data from primary and secondary sources were compiled and processed for various analysis needed for this project. Both primary data and statistical data were analyzed with SPSS and Microsoft Excel. For better analysis, graphs, charts and tables were prepared.

10. **Preparation of Proposed Plan and Design:** Based on results of survey and analysis, it has been incorporated the findings in the design to improve current situation and make the road pedestrian friendly. Detail design on the road infrastructures and other facilities both for the pedestrians and vendors, permitted location for vendors etc. have been prepared.

11. **Preparation of final report:** Analysis of data, major findings, design proposals, recommendations and all other woks regarding this project is summarized in the final report. Also related graphs, charts, sketches and photographs have been added with the report.

Chapter 4: Study Area Profile

The study area is located at Rayer bazar, Dhanmondi, Dhaka. The area is basically a residential area which has some important commercial building too. There are some educational institution in the area. Most of them are primary, secondary educational institution. All the roads are local road in the study area which connected to Shatmosjid road which is a collector road.

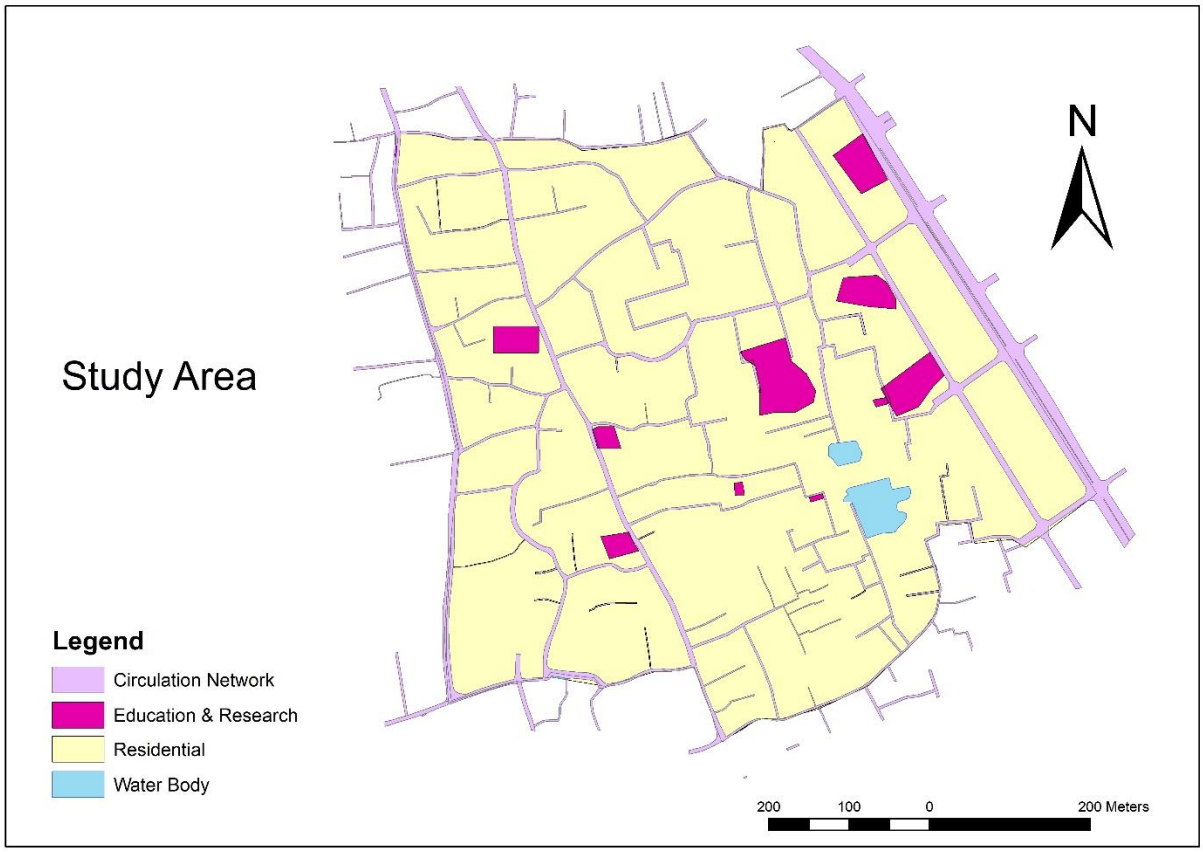
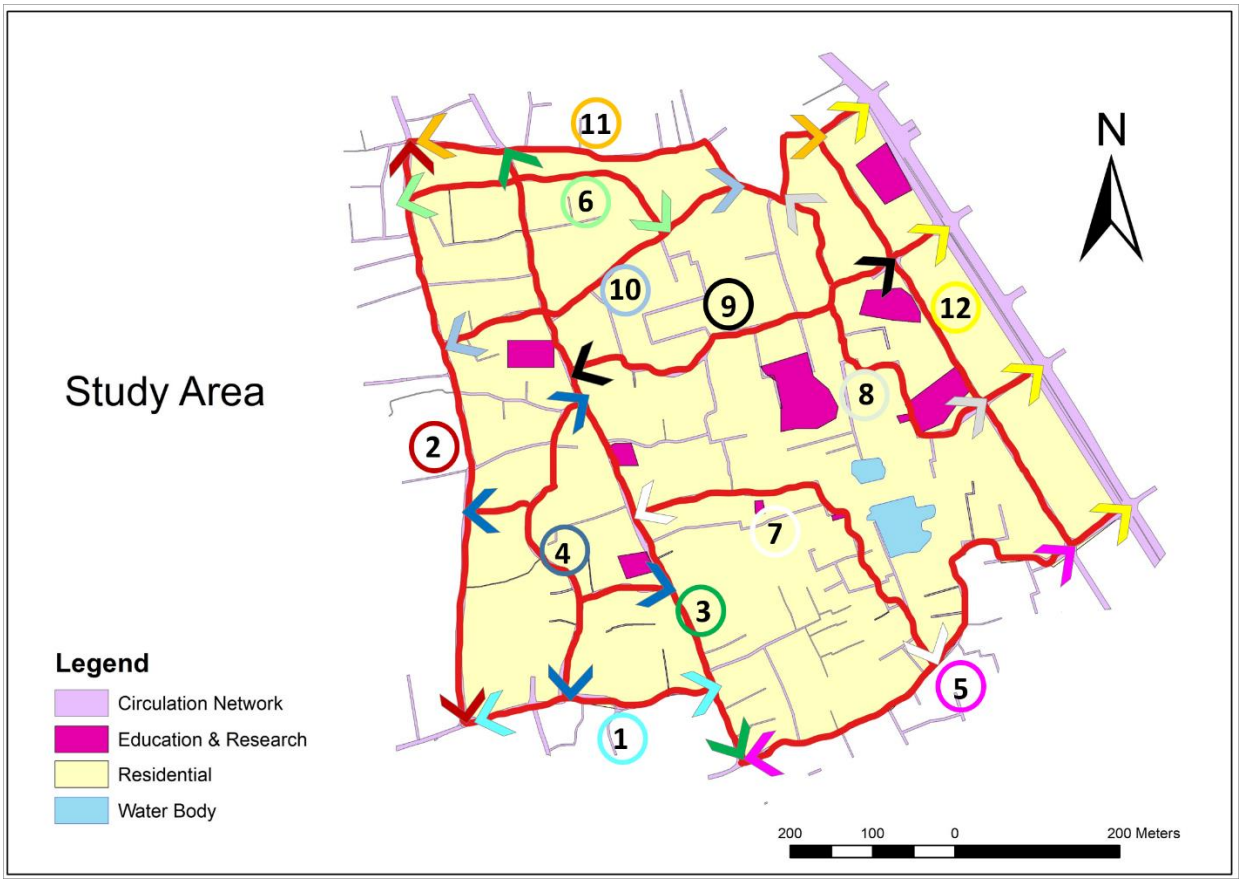


Figure 1: Map of the study area

Source: DAP & Author

Chapter 5: Data Analysis and Interpretation

Data analysis and interpretation is one of the most important parts of any research. It can extract the hidden information from the raw data. To make the data analysis part easy, we divided the existing roads of the study area into 12 segments. The road segment map of the study is included below.



Source: DAP & Author

Figure 2: 12 Road Segment map of the Study Area.

5.1 Existing Condition of Roads of the Study Area

To study the condition of the existing roads of the study area, we collected the data through reconnaissance survey, physical feature survey and traffic volume survey. Data of physical feature survey is collected by questionnaire survey and checklist. Traffic volume data is collected on peak hour (12.00 PM – 1.30 PM) when the morning shift of school ends and day shift starts.

Table 1: Condition of Road Segments of the Study area.

Road Segments	Width (ft.)	Carriageway Condition	Footpath	Facilities for Disable People	Street Lamp	Existence of Crossing Aid	Speed Control Device
1	30	Good	No	No	Yes	No	No
2	28	Good	No	No	Yes	No	Yes
3	18	Good	No	No	Yes	No	Yes
4	15	Partly Broken	No	No	Yes	No	No
5	16	Partly Broken	No	No	Yes	No	Yes
6	15	Partly Broken	No	No	No	No	Yes
7	14	Partly Broken	No	No	Yes	No	Yes
8	12	Partly Broken	No	No	Yes	No	No
9	16	Partly Broken	No	No	Yes	No	No
10	15	Partly Broken	No	No	No	No	No
11	15	Partly Broken	No	No	Yes	No	No
12	25	Good	Yes	No	Yes	No	Yes

Source: Author's Calculation

Road width and Carriageway condition: All the roads are used for the circulation of motorize and non-motorize vehicle and pedestrian in the study area. These roads are being used as two way circulation path. But the ROW (Right of Way) for the most of the roads are too narrow to carry motorize vehicle. Only three of the selected twelve segments has road width more than 25 feet in the area. Other nine road segments has the road width between 12 to 18 feet. Most of the segment's carriageway is partly broken in the study area. Carriageway of relatively wider segments are in good condition.

Footpath: Elven of the selected twelve segments has no footpath for pedestrian passage in the study area. Hence, there is no facilities for the passage of disable people in the area. Only one road have footpath in the area which has 5ft width in both way. But the footpath is not

continuous along with building frontage for which people are not using this spontaneously. The footpath has no facilities for disable people.

Most of the road segments has street lamp in the study area. Of which some are functioning and others are not functioning well. And quantity of street lamp is inadequate for all the segments in the area. Two segments has no street lamp at all which make these roads unsecured for pedestrian use. There is not a single devices, traffic signal or sign as road crossing aid for the pedestrian in the study area. Six of the selected twelve segments has device to control vehicle speed. Only speed bumps or speed breakers are using to control speed in these segments. Whereas other six segments has no device, traffic signal or sign to reduce vehicle speed. Which increases the aggressiveness of the drivers in the area and make these roads unsecured for pedestrian passing.

Figure 3: Broken carriageway

Figure 4: Good carriageway condition

Pollution: Air pollution and sound pollution is in moderate level in the study area. Unnecessary horn of motorized vehicle is the main cause of sound pollution in the area. Roadside construction work and broken roads also creates sound pollution. On the other hand, PM (particulate matter) is the main source of air pollution in the area.

Figure 5: Solid waste causes air pollution.

Vehicle emission and foul odor solid waste is also another reason for air pollution in the area. Absence of dust bin makes people throw their solid waste randomly which increases air pollution.

Table 2: Condition of Road Segments of the Study area

Road Segments	Illegal Parking	Illegal Encroachment	Sound Pollution	Air Pollution	Public Toilet	Dust Bin
1	Yes	Yes	Moderate	Moderate	No	No
2	Yes	Yes	Moderate	Moderate	No	No
3	Yes	Yes	Moderate	Moderate	No	No
4	Yes	Yes	Moderate	Moderate	No	No
5	Yes	Yes	Moderate	Moderate	No	No
6	Yes	Yes	Moderate	Moderate	No	No
7	Yes	Yes	Moderate	Moderate	No	No
8	Yes	Yes	Moderate	Moderate	No	No
9	Yes	Yes	Moderate	Moderate	No	No
10	Yes	Yes	Moderate	Moderate	No	No
11	Yes	Yes	Moderate	Moderate	No	No
12	Yes	Yes	Moderate	Moderate	No	No

Source: Author's calculation

Parking: Parking facilities is not sufficient in the study area. Only two segments has parking facilities which are off street category. None of the segments has on street parking facilities in the area. Which creates illegal parking problems in all the segments. Private cars and rickshaws are mostly responsible for illegal parking in the area.

Figure 6: Illegal parking of CNG

There is no public toilet in the selected segments of the study area which is an important element for pedestrian Friendly Street. Also there is no dust bin in the selected segments. For which people throw their refuse or garbage haphazardly. Which make the segments dirty.

Illegal Encroachment: Illegal encroachment of roads and footpath is occurred at all the selected segments of the study area. Most of the roads are encroached by road side shops. Some segments are permanently encroached and some are temporarily encroached by shops. Roadside building construction work also encroaches some of the roads in the study area. Some vendors are illegally encroach roads and footpath in the area.

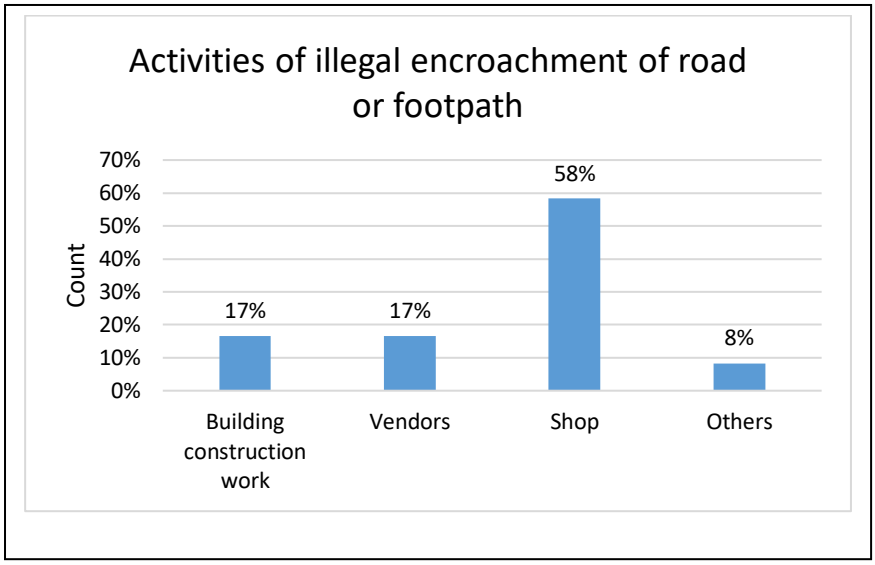


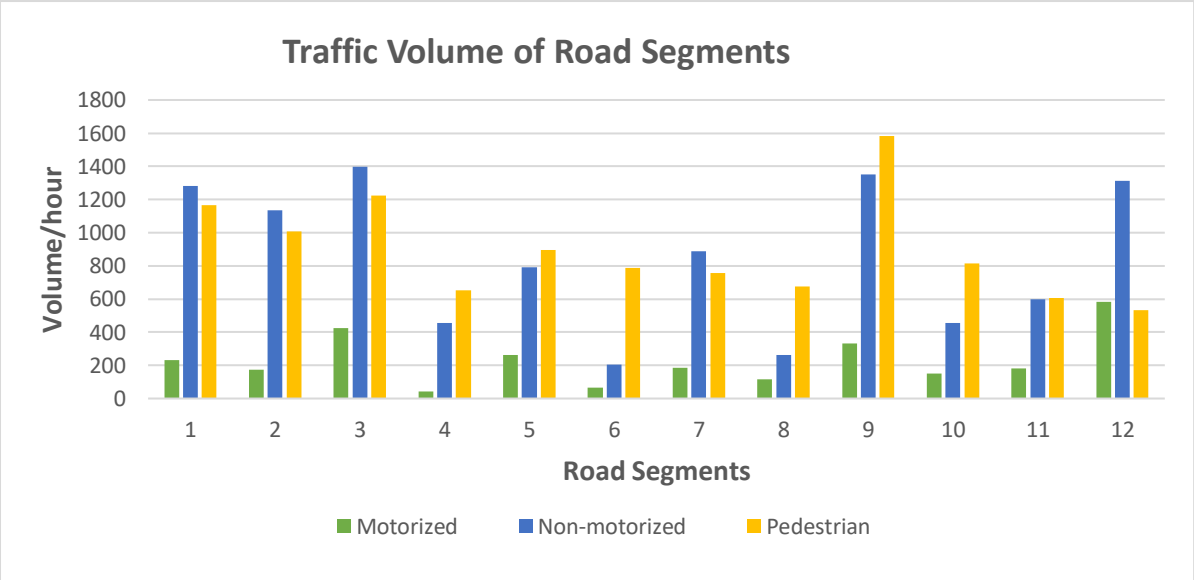
Figure 7: Activities responsible for illegal encroachment of road.

Figure 8: Illegal encroachment by shop.

Figure 9: Illegal encroachment by construction work.

5.2 Traffic and Pedestrian Volume of the Study Area

All the selected road segments are local road which mostly used by the local people of the area. Volume of motorized vehicle is comparatively less than non-motorized vehicle and pedestrian in the study area. Some segments has high volume of motorize vehicle as well such as segments twelve, three and nine. Segments one and two are the wider road of the area but their volume of motorize vehicle is not as much as their width. They are dominated by non-motorize vehicle and pedestrian. Volume of pedestrian and non-motorize vehicle are nearly equal for most of the roads in the study area.



Source: Author's Calculation

Figure 10: Traffic and Pedestrian Volume of the study

Only segment 12 has footpath in the area but pedestrian volume is lowest for this road as the footpath is not continuous and user friendly. Segments four, five, ten and eight is dominated by pedestrian as they are relatively narrower roads in the area. Segment 1,2,3,9 and 12 are the busier roads in the study area as their width allow these roads to carry a large number of vehicle and pedestrian.

Figure 11: High volume road

Figure 12: Low volume road

Chapter 6: Design proposals and guidelines

The study area have already grown in haphazard ways with narrow streets without any facilities for pedestrians, roads are only for vehicular movement. As a result, though most of the roads have width below 20ft, almost all the roads are congested with motorized vehicles. The study area is connected with a collector road, Shatmosjid road.

Proposals under the first objective is provided below to implement for the improvement of walkability of the study area.

Categorization of roads: Roads will be of three types according to its width; pedestrian only roads with width below 15ft, road for only non-motorized vehicles along with pedestrian with width 15ft to 24ft and roads for both non-motorized and motorized vehicles with width above 24ft.

- Pedestrian only roads have narrower width incapable of accommodating any vehicle. Road no- 7 and 8 of the study area will be the pedestrian only road.
- Second type roads will have restrictions on motorized vehicles (road no- 4, 5, 6, 9, 10, 11). These roads has road width of 15-24ft. These roads will be used only for pedestrians walking and non-motorized vehicles such as rickshaw, bicycle and school van for children and van for collecting household waste for which 12ft is enough to move in two way (Ministry of Communications Roads and Railways Division, 2000). Vehicles such as ambulance, fire brigade will have access in emergency situation. Car with aged people, infant, sick, handicapped people will get relaxation from this rule.

Footpath will be 10ft (Jani & Kost, 2013) but for space constrained 15ft road will have 3ft footpath at one side of road dedicatedly for pedestrian zone without frontage and furniture zone. Carriageway can be highest 14ft width and rest of width will be used for footpath with three zone of it.

- Roads above 24ft width will have access to private car, micro bus, small covered van and truck for which 18ft is enough to maneuver (RHD manual). Along with these

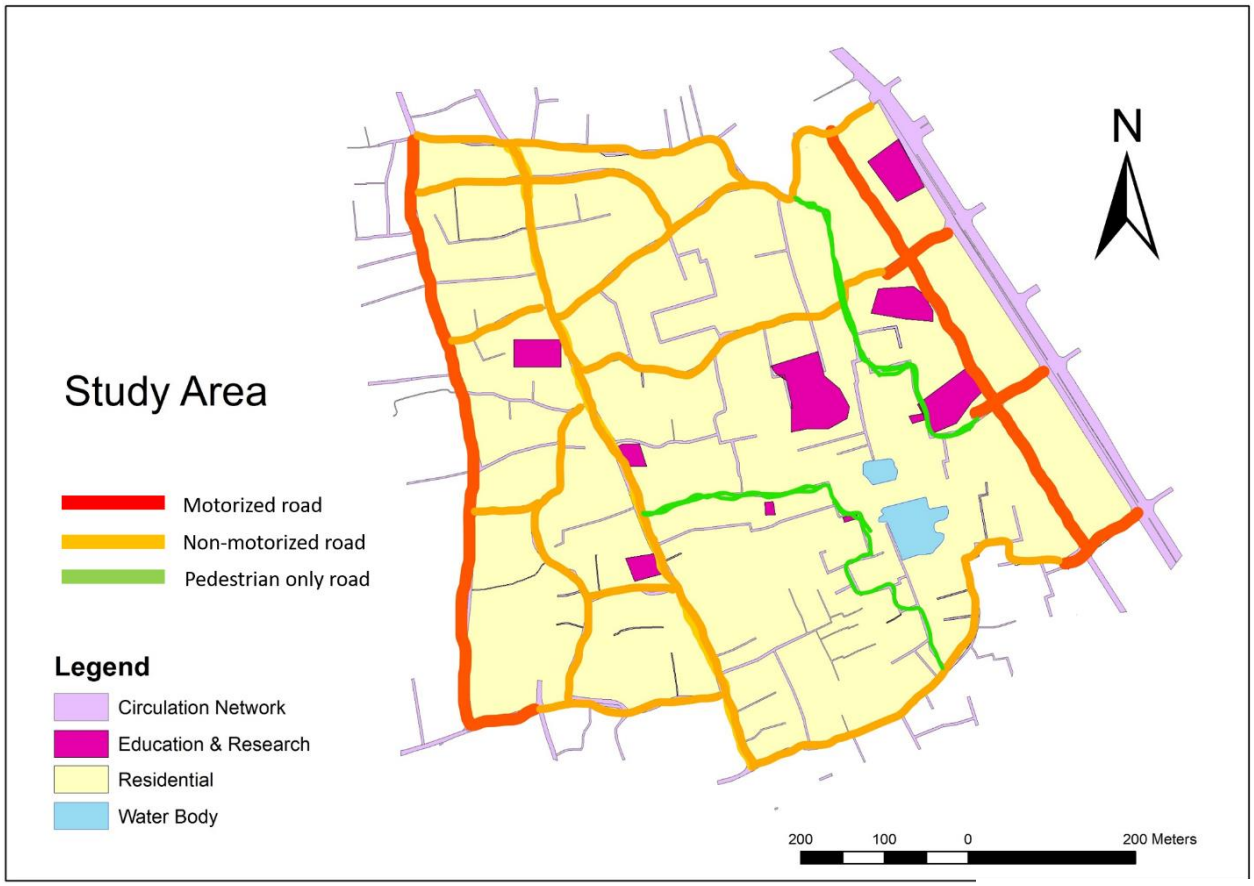


Figure 13: Categorization of roads in study area Source: DAP & Author

motorized vehicle, non-motorized ones will also ply on the 18ft carriageway. There are three roads of such type (road no. 1, 2, 12) in the study area. Carriageway can be 24ft of highest width considering available space (Ministry of Communications Roads and Railways Division, 2000) and rest of width will be used for footpath (minimum 10ft for two wheelchair) (Jani & Kost, 2013). For space constrained footpath can be 6ft at least dedicatedly for only the pedestrian zone.

- Another type of roads have been found in the study area, dead end road. Children are found playing on those. For not interrupted by the through traffic they are safe for children and elderly people for walking, playing and gossiping.

Footpath elements: Footpath will have a flat walking surface with a minimum width of 1.8m (5.9ft) and will be at a height of not more than 6 inches from the carriageway and guide tiles will be laid along the length of the footpath to assist persons with vision impairments. For ensuing comfort, continuity, and safety, the footpaths are divided into three main zones: the frontage zone (also known as "dead width"), the pedestrian zone, and the furniture zone (Jani & Kost, 2013).

- Minimum width for frontage zone is 0.5m (1.6ft).
- The pedestrian zone provides continuous clear space for walking. The clear width of pedestrian zone must be at least 1.8m (5.9ft) in order to accommodate two wheelchair users at the same time and must be entirely free of obstructions.
- Furniture zone will be at least 1m (3.3ft) which will accommodate vendors, trees, seating and utilities (Jani & Kost, 2013). For being a residential area, household waste is collected by the garbage van by municipality. A system of collecting waste from street dustbin will be developed by them and every local road will have at least one street dustbin where there is crowd in the road.

Vendors: Street vending makes public space safer by contributing "eyes on the street," particularly on streets lined with compound walls. The furniture zone of the footpath is ideal locations for vending. When road width is enough to provide 10ft footpath with 3.3ft furniture zone, space for street vending will be provided there. Different color of tiles in footpath will indicate the space for street vending. In vehicle restricted time of school zone in beginning and ending of school, a width of 3.3ft of one side of road can be used for street vending.

Lighting: Lighting should be spaced to provide uniform illumination. Streets that are 50 feet wide or less may have street lighting in an alternating pattern spaced every 180 feet. Pedestrian lighting should be placed between street lighting at 60 foot spacing (i.e., two pedestrian luminaires) (Anonymous, 2017).

Drainage: curb and gutter will be provided for road drainage to drain the surface run off. In built-up areas channel drains deeper than 250mm should be covered for the safety and convenience of both pedestrians and vehicles. The drain should be capable of being cleaned and maintained easily (Ministry of Communications Roads and Railways Division, 2000).

Parking: Any parking, waiting or stopping of any type of vehicle without designated parking facilities won't be allowed in the narrow roads of the neighborhood. Roads which has 40ft (20ft

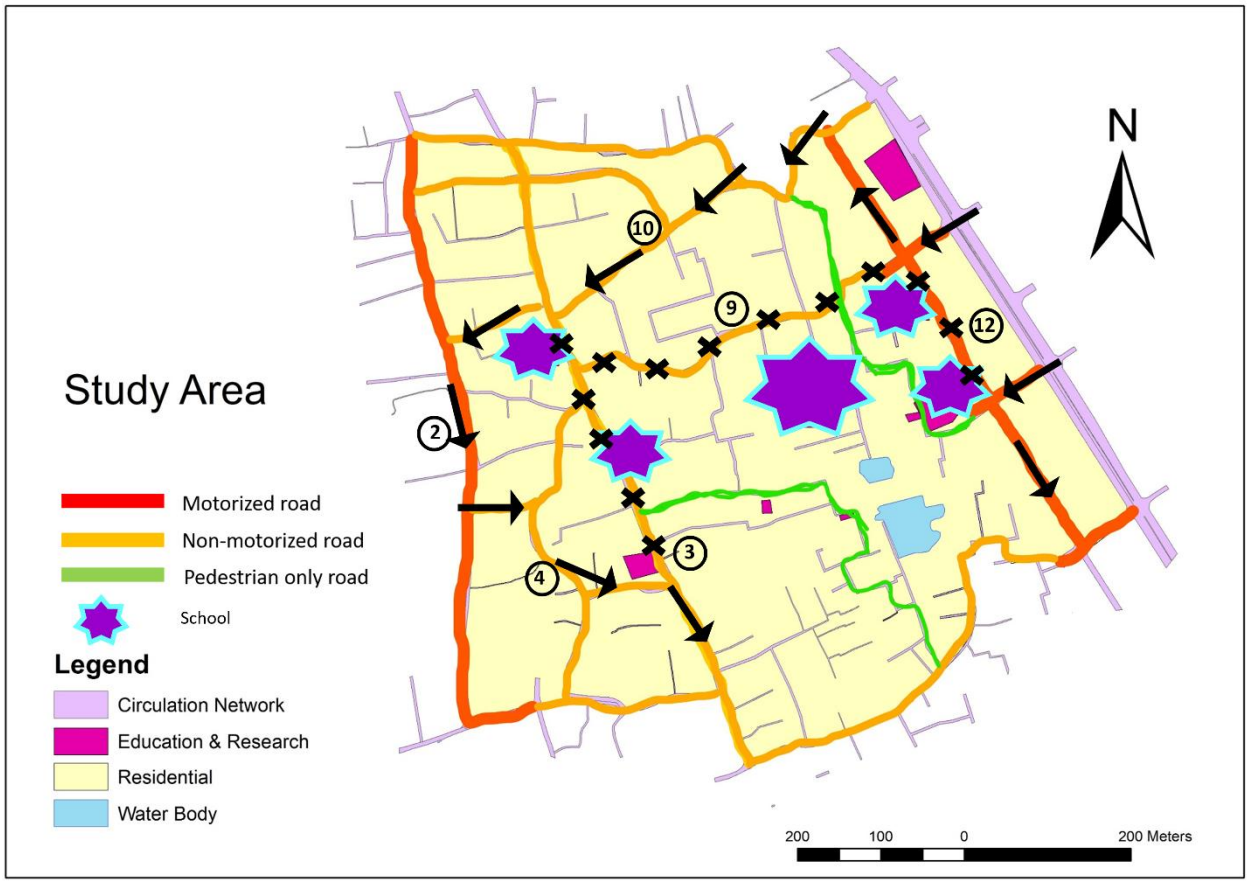
for carriageway + 10ft for footpath +10ft for parallel parking) or above width can have parallel parking facilities in the road (Rahman, n.d.).

Crossing: pedestrian crossings should be provided at regular intervals (i.e., at least every 200 m) to ensure that pedestrians have a safe place to cross. To ensure safety, crossings should be constructed as tabletop crossings with ramps for vehicles. The purpose of a tabletop crossing is to reduce vehicle speeds and also emphasize the presence of the pedestrian crossing. Warning tiles should be placed at the edge of the footpath to warn the visually challenged about the carriageway. Crosswalks should be elevated to a level of the adjacent footpath (150 mm above the road surface) with ramps for motor vehicles. Crossings should be as wide as the adjacent footpath and never narrower than 3 m (Jani & Kost, 2013).

Intersection design: Intersection design should manage conflict in a way that enhances safety for pedestrians. The preferred design is to raise the intersection to the level of the footpath. Vehicles slow down when crossing over the ramp, and a material difference emphasizes that they are entering a shared space. Smaller turning radii increase pedestrian safety by reducing vehicle speeds.

Proposals under second objective is provided below for the improvement of transport circulation pattern of the study area.

School Zone: School zone is a defined portion of a roadway associated with a school. In the beginning time of school (8 am to 10 am) and ending time (12pm to 2 pm) vehicles movement will be restricted in school zone which is 200ft from school front (Texas Department of Transportation and the Federal Highway Administration, 2009). Alternative route will be used at that time. In the other times vehicles will maintain speed of 25 km per hour in school zone. All these directions will be provided by the road signage before starting of the school zone and will be maintained by the community police.In the study area, total seven high schools and primary school are situated. West Dhanmondi Yousuf High School, Ali Hussain Girls' High School and Dhanmondi Kochikontho School are beside road no. 9. The alternative route for this road will be road no 10. Jafrabad Government Primary School and Jafrabad Adarsa Government Primary School are beside road no. 3. The alternative route for this road will be road no 10 to 2 to 4 to 3. Maple Leaf International School and Ananda Niketon European School are beside Road no. 12 which is motor vehicle permitted road. For these school, a certain part of the road no. 12 will not permit any vehicle at beginning and ending time of these schools. Alternative route will be used.



Source: DAP & Author

Figure 14: Alternative route plan for school zone

Time bound leaving and entering of residents' motor vehicles: If there is any residence that has no access to the motorized vehicle permitted road but the residents own car and use the off-site parking facilities of the building then their car must leave the parking before 7 am and can enter the parking after 11 pm. These car will be marked by sticker.

Ward wise registered rickshaw pullers: While rickshaw is an important public vehicle in the context of our socio economic condition, there will be a list of registered rickshaw puller for a ward. They will have simple identifiable uniform delivered by the ward authority. Except them, other rickshaw puller can enter the ward from another ward but can't wait for having another passenger. He must leave the ward after dropping off his passengers in his destination in the ward.

Ward wise community police: Ward wise a traffic control and management committee will be formed with community police to maintain and manage all those measures.

6.1 Detail Design of Road Categories

1. Detail design for ROW (Right of Way) more than 25 feet: These roads is categorized for carrying motorized and non-motorized vehicle. This segment is designed for a ROW of 30 feet. A both way 6 feet footpath and 18 feet carriageway for both way is designed. All the elements of footpath such as sufficient width, facilities for disable people, lighting, tree plantation, dust bin, public toilet etc. should be given in a sufficient quantity. Footpath height is 6 inch above the road surface.

Figure 15: Detail design for the road width more than 25 feet.

2. Detail Design for the roads having ROW between 15 to 24 feet:

Figure 16: Detail design for roads carrying only non-motorize vehicle and pedestrian.

These roads are designed to carry non-motorize vehicle and pedestrian. The ROW of this category road is between 15 to 24 feet. But this design segment is designed for a 20 feet width road. Both way pedestrian segments are of 4 feet and non-motorize vehicle segment is both way 12 feet. All the road facilities should be sufficiently provided.

3. Detail Design of only Pedestrian Segment:

These roads is designed for only pedestrian use. ROW of these category road is below 15 feet. Space for vendors and coffee shop etc. is designed at one side of the roads and in other side of the road seating arrangement and other road elements is designed.

Figure 17: Detail design for only pedestrian use road segment

4. Detail Design for Dead end Road:

There is another road category of roads in the study area which are dead end type. These roads directly connect to a building and end in the front of the buildings. These roads are designed for only pedestrian use and social gathering purpose. An area is determined for children playing zone in these road segments. Sufficient seating arrangement should be provided for the people to gathering in the roads.

Figure 18: Detail design for dead end roads of the area.

5. Detail design of 4 leg intersection of the area:

There are some four leg intersections in the study area. This intersection is designed for the motorized and non-motorized vehicle carrying roads where all the roads having width more than 25 feet.

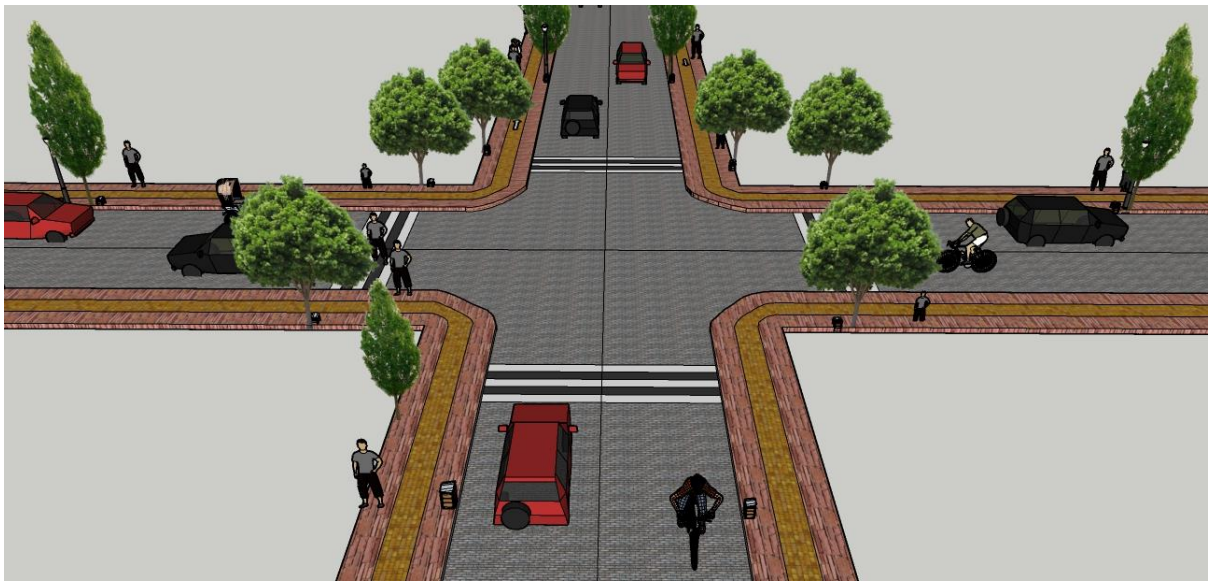


Figure 19: Detail design of four leg intersection

6. Detail design of three leg intersection of the area:

There are some three road intersections in the study area. This intersection also designed for motorized and non-motorized vehicle carrying roads which have width more than 24 feet.

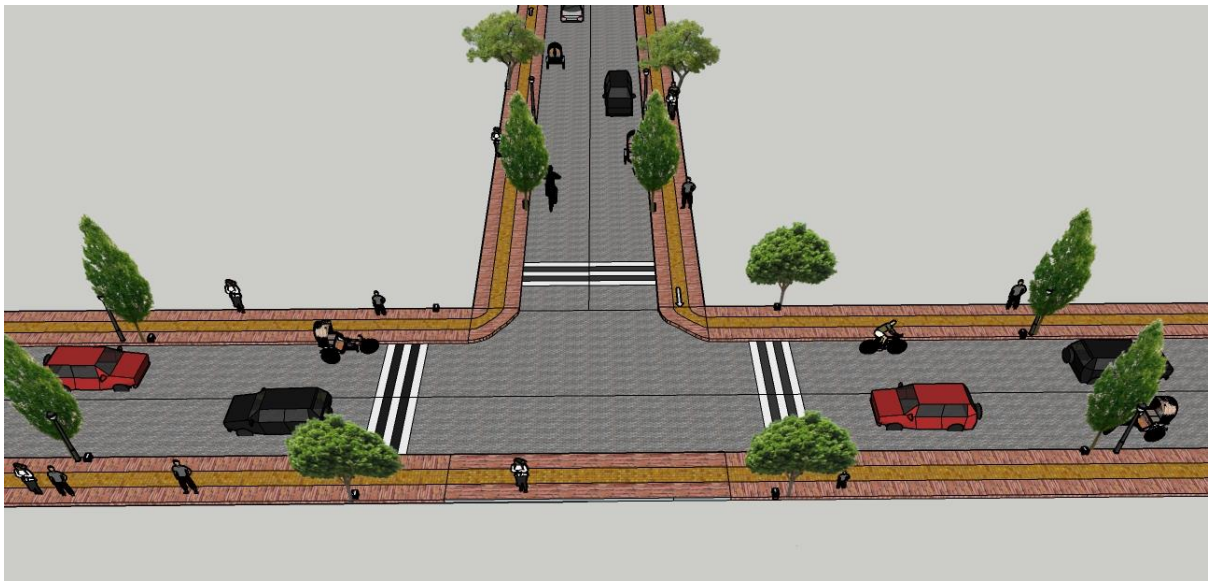


Figure 20: Detail design of three leg intersection.

Chapter 7: Conclusion and Recommendation

Making some of the street motorized vehicle free and car free might make some conflict with the car owner. But there should be public forum or platform through which this kind of conflict can be resolved. Making a local area pedestrian friendly is so much important as it has so many advantages. Pedestrian friendly transport increases the social, environmental and economic value of the area. Children and women can walk safely as it increases the safety measurement. Better human health is ensured as overall environment is improved and people use walking to commute in short distance. Again, overall traffic circulation pattern will be increased and traffic jam and haphazard traffic movement will be reduced. People should aware of using dustbin instead of throwing garbage haphazardly. And also authority should clean the public toilet regularly. As vendors are an important part of the area, they have to sit only in the specified area.

To maintain a better environment of pedestrian friendly transport, regular maintenance and monitoring should be ensured by authority. Traffic police should be enforced for these tasks. There should be penalty system for breaking any traffic signal, sign and rules for vehicle which should be followed strictly. Maintaining all the rules and regulations and increasing the public awareness, this area would be pedestrian and environmental friendly.

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