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Nodes and Streets: Exploring the Pedestrian Mobility Pattern in the Intersections of the Streets in Dhaka City

Zishan Fuad Choudhury*, Sanjida Ahmed Sinthia

Department of Architecture, Ahsanullah University of Science and Technology, Bangladesh

* Corresponding email: zishan.arch@aust.edu

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ABSTRACT

Viable pedestrian movement has always been a challenge for urban planners and designers. The modern tendency is to create mobility in pedestrian environments and, at the same time, limit the dependency on vehicular movement. Pedestrians play an important key role on reshaping nodes and streets. Mental mapping guides a pedestrian to mobilize from one point to another, creating an individual pattern. When hundreds of points are created by urban pedestrians, a new order of network emerges, and different functions are often disrupted in order to support them. These changes are responsible for the urban fabric; they create a certain dimension and a vibrant network of movement.

Dhaka, the capital city of Bangladesh, thrives on vehicular dependent movement, but the majority of the population still comprises pedestrians and depends only on public transportation. The pedestrian population has dramatically increased due to constant migration brought about by labor market changes, better employment and fast moving lifestyles. Although the pedestrians are responsible for the vibrant environment, due to their mobility pattern, a major upheaval also results from unplanned and haphazard street functions at nodal points serving the pedestrians. This paper evaluates the causes of pedestrian movement patterns, and illustrates the problems with and identifies the ineffective functions that create a node. Finally, on the basis of analysis, an outcome of urban node principle has been proposed with the aim of enabling more effective movement and a holistic kind of functional urbanism.

Keywords: pedestrian, mobility, streets, nodes, movement patterns

INTRODUCTION

In the modern concept, where public space is referred to an integrated and complex spatial system, elements (streets, nodes, green areas, building structures, etc.) are connected in a certain way. In this sense, public space has an effect on social and economic characteristics in creating a network of mobilization. Streets and the connectors play vital roles and should be considered, analyzed and designed with care as they are integrated with functional mobility and the building systems.

In this arena, the structure of urban tissue affects human behavior; the way people move from their homes to destinations is important. On one hand, the complex properties of urban networks determine accessibility to a particular location, and, at the same time, create necessary functional spaces. On the other hand, pedestrian mobility patterns directly affect the location of specific functional masses.

Studies show that cities tend to enjoy the diversity of vivid patterns of functional mobility according to size, culture, and demographics. This is due to either fast moving transport, or many non-motorized methods. Each city represents its own identity and culture through movement on its streets and footpaths. Though metropolitan cities are intertwined with many layers of problems**,** pedestrians play a vital role as the main actors shaping the walkways and intersections.

According to the 2020 metro area ratings of largest world cities by population, the capital of Bangladesh has now been turned in to 6th largest mega city of the world. The constant migration to the city is one of the reasons Dhaka is thriving and expanding in many layers. One of the layers is the connectivity throughout the city. Due to the increasing population, the demand for travel options is also increasing very rapidly in the city; thus, causing enormous pressure on the existing transport infrastructure (Pedestrian Behavioral Pattern and Preferences in Different Road Crossing Systems of Dhaka City). Walkways, then, are of great importance; to make use of public transport or to walk to a nearby shops or offices, one must use the. Most of the time the walk-ways are occupied by illegal structures, hawkers and other establishments. The policy makers, for incomprehensible reasons, have prioritized roads over improving the walkways and support facilities for pedestrians. The order should be reversed to support the pedestrian mobility pattern by considering foot traffic movement to a greater extent. Even as the capital, Dhaka is one of the least motorized cities in the world. Even though urbanities mostly depend on their feet for transportation, little has been done to significantly improve pedestrian movement.

OBJECTIVES AND METHODOLOGY

The main objective of the study is to understand the pattern of movement in the nodes and to identify the problems. When analyzing collective movement, one of the main research challenges is to detect movement patterns that provide evidence of specific interactions between moving objects and their environments (Laube, 2009). The movement of an object is represented a trajectory, and individual trajectories are measured and analyzed in terms of stops and moves. A node thus acts as an activity hub that shapes the corners due to constant mobility within the space; hence, nodes affect the surrounding built environment. To understand the ongoing changes within the area of Dhaka, two important nodes have been chosen for a case study in Uttara satellite town.

The study went through a systematic process of analyzing the nodes and the streets in the selected nodes. In addition, case studies have been investigated to understand the patterns of nodes and streets in busy intersections of world cities. The whole process was done in a field survey method in the selected nodes; by interviewing pedestrians and vendors in order to understand their mobility patterns. Finally, on the basis of the study, an urban node principal has been chalked out, and a recommendation has been formulated.

STREET AS PUBLIC SPACES

Open areas, like plazas act as a conglomeration of space with built elements. Activities in the form of various events and happenings take place in those areas. They form the backdrop to an urban drama. In many cities of the world, streets and walkways are meant to serve the plazas and connect the different areas of the city. Either through motorized or non-motorized travel methods, the plazas and open spaces give a notion of centrality.

Every day, inhabitants of the city commute from one place to another, with destinations including places of work, shopping areas and other social facilities. Many jobs involve more than one location in a single day. Trip patterns are generated by daily return trips from residences to work places, or from one work place to another 'meeting place.'

Here, the term 'meeting place' refers to locations where people go for work and other purposes. Trip patterns are thus dependent on the relative location of residences and meeting places in metropolitan cities.

To support the functional requirements of the 'meeting places,' urban spatial structures in the nodes and streets play an important part on the surrounding built environment. As the nodes are key points where the transit-oriented development occurs, to support the commuters, changes in land uses and transformation of the spaces are obvious.

In most cases, nodes and streets are subject to constant changes in land use. Multiple uses of streets spaces ensures an uneven pattern of foot traffic – a kind of a captive market of office workers, urban dwellers and conventioneers. In some cities, the node landmasses are the accumulation of urban commercial spaces become hubs for transit-oriented development (TOD). People are not necessarily using the spaces for shopping or other activities. Rather, they tend to use the space for the purpose of moving from one place to another, or to access public transport.

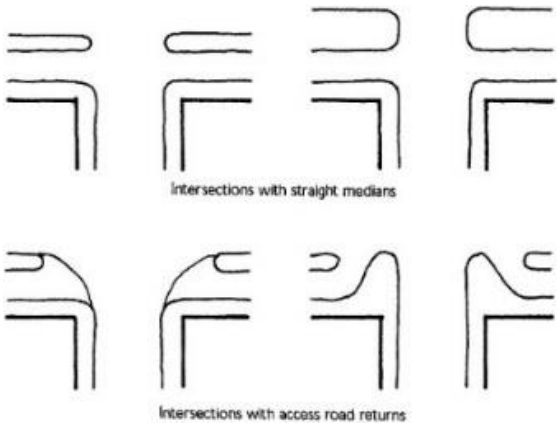
As Berman (1988) explains,

"[t]he essential purpose of this street, which gives it its special character, is sociability: people come here to see and be seen, and to communicate their vision to one another, not for any ulterior purpose, without greed or competition, but as an end in itself…"

One cannot deny the fact that, nodes and streets should permit people to walk at varying paces, with neither a sense of crowding or blocking the paths, but those negative issues occur every day while moving from one place to another. Footpaths also must be safe, primarily from vehicles. To understand pedestrian comfort level, we must learn from first-hand accounts what makes the nodes so important. Due to transit-oriented development in the city streets, secondary and tertiary roads are source of foot traffic. Of course, all this foot and vehicular traffic mixes together where there is a junction of streets. Walkways are not crowded at 3-4 people per minute per meter; any kind of properly designed walkway can handle up to 8 people per minute per meter.

Figure 1

Intersection configuration (Multiway boulevard, Elizabeth Macdonald)



Crowding starts at perhaps 13 people per minute per meter, and that most typically happens where there is an obstacle of any form (shop, structures, etc.) on the paths, causing the overall speed to slow.

Some people can block out distractions and walk at a leisurely pace even among a crowd, but when density exceeds about 17 people per minute per meter, people are forced to move from walkways to the streets (Jacobs, 1993). This is a common scenario in the nodes, especially in the third world cities where land is vulnerable and no millimeters can be spared.

URBAN NODES AND STREET IN THE DHAKA CITY: PRESENT SCENARIO

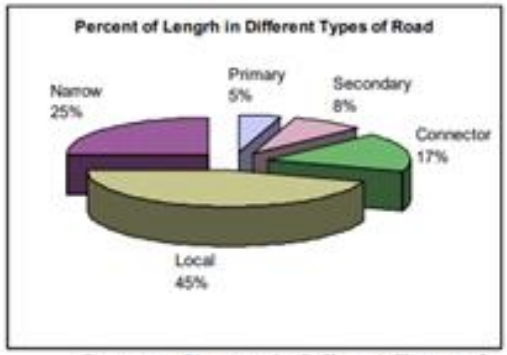
Before jumping in-to the case study area, it is necessary to understand the present scenario in the intersections of nodes and streets of Dhaka city. In the city of Dhaka, there is a lack of public places and plazas. Spaces are not designed or prepared to act as major nodal activity areas where there is a confluence of people. Urban nodes and streets in Dhaka lack defined boundaries or identification. Dhaka has experienced distinct reformation over the decades. Due to the unplanned nature of the city, the addition, alteration and modification has happened almost entirely on an ad hoc basis. The victims of this haphazard approach are many established public places and natural amenities, which have often been destroyed. Many open areas have lost significance because of the ongoing proliferation of commercial and mixeduse developments. Whenever there is a new building, the mobility pattern changes to support the passersby or the occupants. Changes in the physical patterns of the space leads to changed activities, and the streets are, in turn, transformed by those activities. Sometimes pedestrian walkways are occupied or converted to host various functional activities. Traditional market squares that used to be places of many activities have been filled with additional shops. Market-driven economic pressure forces changes to the physical patterns of space -- not to functional, but, rather, chaotic. These changes to the market places, squares and plazas too often diminish their character. “These undesirable changes not only have caused a significant reduction in the number of places residents are connected to, they also have increased the sense of ‘placelessness’ in society, making people less concerned about what is happening to the city” (Imon, 2016).

On average, streets, sidewalks and alleys occupy between 25 and 30% of our urban land. But, for a sustainable city measure, it is not certain that this percentage is enough. Various factors are included since the size of any city is limited, but increasing migration to the city tends to increase the demand for travel by motorized vehicles and through pedestrian mobility. While 25%-30% roads and walkways is considered to be sufficient for a city, despite the fact that Dhaka is densely populated, the city’s actual road space is far lower than these requirements.

The total space occupied by the roads and streets of Dhaka Metropolitan City is only 9% of its total space, while that of other mega cities covers approximately 25%. Furthermore, though 9% of the city comprises road area, as can be seen in Table 1, pavement area is only 6% of total area (Mahmud, 2009).

Figure 2

Percent of Length in Different Types of Road

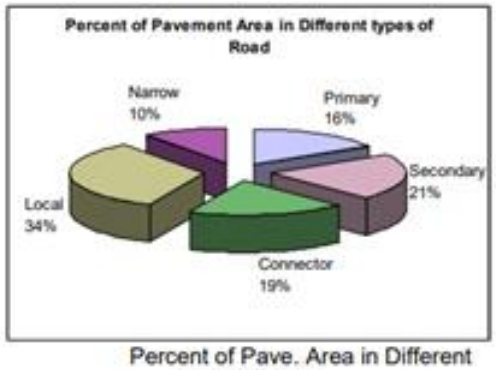


Percent of Length in Different Types of Road

Note. From *Identify the deficiencies of landuse-transport development in Dhaka City,* by Mahmud, S. M. S., 2009, Bangladesh University of Engineering and Technology. Copyright 2009 by Mahmud, S. M. S.

Figure 3

Percent of Pave, Area in Different Types of Road



Percent of Pave. Area in Different Types of Road

Note. From *Identify the deficiencies of landuse-transport development in Dhaka City,* by Mahmud, S. M. S., 2009, Bangladesh University of Engineering and Technology. Copyright 2009 by Mahmud, S. M.

Table 1

Length, pavement area and road area of DCC by road type

Classes of roads	Length (km)	Percent of road length	Pavement area (sq. km)	Percent of pavt. area	Percent within all area	Percent of road area	Percent within all area
Primary	61.45	4.78	1.46	16.47	1.08	15.67	1.41
Secondary	108.20	8.41	1.86	21.05	1.39	19.94	1.80
Connector	221.35	17.21	1.68	19.04	1.25	20.42	1.84
Local	573.75	44.61	2.93	33.17	2.18	35.19	3.17
Narrow	321.27	24.98	0.91	10.28	0.68	8.78	0.79
Total	1286.02	100.00	8.84	100.00	6.59	100.00	9.01

The less prioritized urban walkways in a mega city like Dhaka create concerns that little thinking has been implemented on behalf of the walking community. The policy makers are often biased by implementing new roads and physical structures for motorized vehicles without concentrating on implementation of walking friendly environments. This discontinuity of the network of mobility gives a series of broken lines towards a destination and, thus, creates a voids. These voids can create a series of disturbances on the streets; such as on walkways where illegal shops disrupt the flow of pedestrians.

Of course, the pedestrians continue stopping, just in different spots; -- wherever they feel necessary to shop or to avail themselves of public transport. The movement to a space by an observant pedestrian that mobilizes him to a variety of locations is an identifiable attribute. In contrast, spatial dependence refers to the persistence of an observed attribute at the local level despite global variation (de Smith et al., 2007). This means, that an observant pedestrian in one location may be similar to another in a location in nearby; hence, creating a similar pattern of movement.

'…the behavior in a crowd strongly depends on the behavior of other persons in the crowd' (Bierlaire et al., 2007, p. 84).

It is clear to say, movement along the walkways or the nodes is determined by the variables that lead to other functional spaces. Due to unplanned settlement and lack of traffic management on the streets, pedestrians reshape the physical parameters of a space with their own behavior. That gives them power to exert control over the streets and walkways as demanded.

The characteristics of old and new Dhaka differ much in terms of social and functional activities. Understanding the idea that node activities depend on the connectors, in old Dhaka, the small lanes act as a gathering places; shops are occupied on the streets and give mixed modes of mobility. In many urban nodes and streets, the main walkways remain on the roads, whereas the sidewalks are rarely visible. Streets here act as a mixed-use transportation channels, and fast mobility is hampered as there are multiples magnitude of speed. Those particular streets give vibrant characteristics to the space. The nodes act as connectors and contribute to the iconic texture of the cityscape. In new Dhaka, the

character of nodes and streets is different. Nodes often act as the busiest intersections of space, whereas fast-moving vehicles are given the highest priority. Except in few elite residential and commercial areas, there are no significant guidelines or design principles governing the patterns of mobility. Rather a chaotic way of movement is presented that creates upheaval and discomfort.

Roads in Dhaka have developed in a piecemeal fashion, and they never have been considered as a comprehensive network of urban mobility. Even the walkways or the roadways have not been developed with standard facilities. Moreover, the organic growth patterns generated in the course of time have never been integrated into planning considerations and never been developed up to any standards (Rajdhani Unnayan Katripakkho, 2015). The majority of the urban areas in Dhaka suffer from such appalling situations; even passengers moving from one destination to another by transport on roads and flyovers also lack convenience as well as orientation. Streetscape treatment in a chaotic form represents a dire condition for a city and the lack of continuity and open space linkage.

PERCEPTION OF AN ENCLOSED SPACE AND VIEW CORRIDOR

According to Alexander et.al. (1987), the boundary of any locality should reflect the complexity of city life where activities overlap in endless combinations. That means the linearity of a street in the locality creates an enclosure of community where the urban fabrics differ from one to another. For instance, in the old town, Shakhari bazaar presents a unique style that reflects the complexity of overlapping activities. The street fronting the ground floor shows immense characteristics of multiple land uses**,** from shop fronts to manufacturing cottages to areas for performing rituals and religious activities. These socio-cultural factors impact the neighborhood and reveal a pattern of mobility where density is one of the key considerations. This pattern changes throughout the day, and spontaneous behavior patterns become integrated with the surrounding space. Again, the constant overwhelming migration to Dhaka puts extra pressure on already limited land and diminishes the urban open space in both quality and quantity. As space for more people to make a living becomes increasingly limited, nodes and streets are available for people seeking to generate income. The results spill over foot traffic areas, creating serious disruption to pedestrian movement patterns. Often, pedestrians are forced to walk on the streets, and the small shops illegally occupy a part of the footpaths and public streets just to support their needs. The owners of these shops feels entitled to use of the urban space, which gives him a sense of power of creating an imaginary boundary to a certain area. Such behavior contributes to changes in the movement patterns. The sense of enclosure is more intimate and apposite for pedestrian movement. The unplanned nature of street occupancy in the urban grid has encouraged pedestrians in the neighborhood to move freely. Despite the fact that roads and walkways are clearly distinguished, the movement pattern is usually haphazard, and make-shift shops that are on the streets are not linear.

Bentley et al., (2013) suggest that physical and visual permeability depends upon how the network of public space divides the environment in-to blocks that are surrounded by public routes. In this way, the lanes of a neighborhood, especially streets in old Dhaka, are more favorable than the main roads. For example, the narrow lanes can only permit slow moving vehicles like rickshaws and human pullers; this creates a notion of everybody having the right to do social and religious activities in the space, and gives a congested image to the city streets. The life on these lanes is relatively slow; this is a desirable situation that brings life to the old city and is reflected on its streets. If the movement patterns are analyzed, such analysis may show a series of patterns that are intermingling and going nowhere. Because of intensive land use in the area and lack of alternate routes, vehicular and pedestrian movements both threaten the ambience.

The major spatial network in Dhaka lacks sufficient definition and standardization in terms of facilities and character, thereby, impairing the ‘legibility’ of the city. The nonexistent nature of a street hierarchy means that there is no clarity of movement patterns and orientation. The lack of

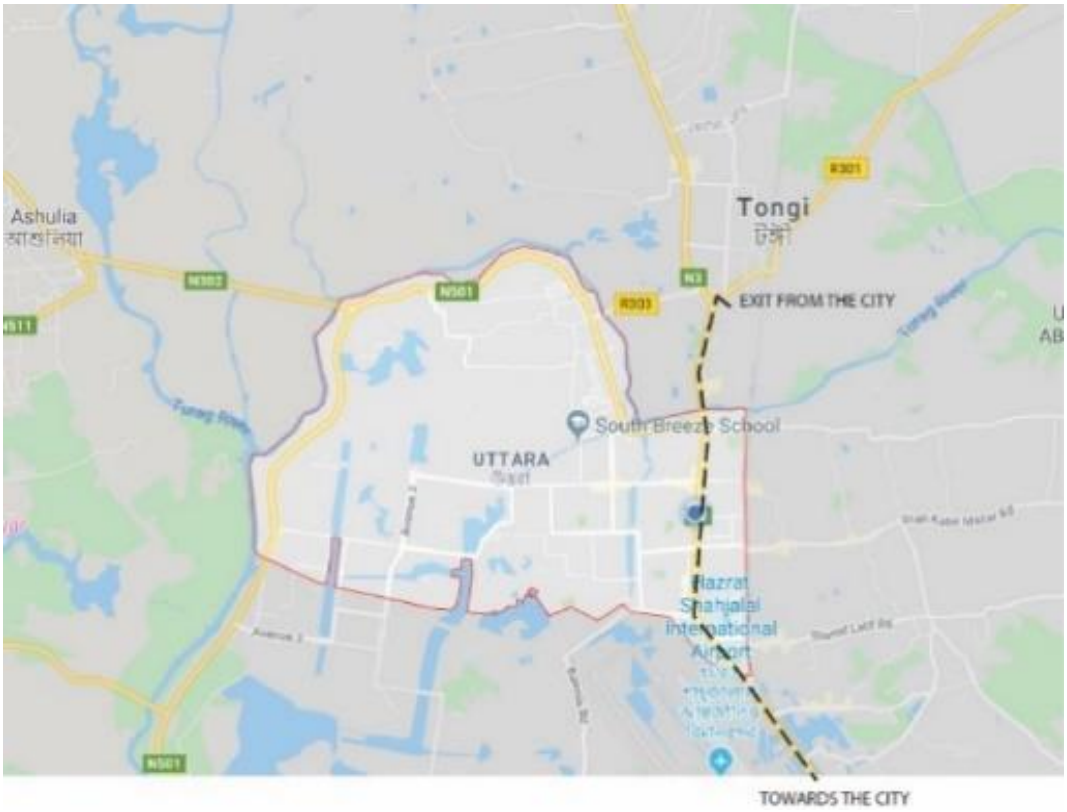
order creates confusion among the pedestrians and ambiguity in the provided services. For instance, the walkways that connect to the intersections are often disjointed and haphazardly organized. All the entry points to the neighborhood lack sufficient definition as points of arrival. Significant view corridors to major landmark like parks, public squares and buildings are undefined and disorganized. Lack of civic amenities for the walkers or visitors are obvious. The views and vistas are often obstructed by the manmade settings, thereby, giving awful impressions to pedestrians. Streetscape treatments that create memorable urban corridors and nodal spaces are nonexistent, and these urban short-comings negatively impact the livability of the city.

SELECTION AND ANALYSIS OF CASE STUDIES

A township project was launched in the northern fringe of the city with the intention of solving the housing problems in a substantial way by encouraging the decentralization of functions. Originally known as the Dhaka North Satellite Township, the name was changed to Uttara Residential Model Town by Dhaka Improvement Trust (DIT) in 1980. Over the years, the town has seen unplanned growth in terms of housing and infrastructure. The individual plots are subdivided vertically in-to a multiple ownership system, but it fails to substantially merge with the existing road network system. Although, as a satellite town, Uttara has its own support systems and designated commercial activities, due to extreme density, the land uses have been transformed by market driven forces.

Figure 4

Uttara satellite town (total area roughly 36.91 km2) population: 345,097



Note. From *2011 Population & housing census: Preliminary results,* by Bangladesh Bureau of Statistics, 2011 (https://catalog.ihsn.org/index.php/catalog/4376). Copyright 2011 by Bangladesh Bureau of Statistics.

The entire township is divided into many sectors. Each sector has its own characteristics and individual perspectives. Some have more residential features, whereas other sectors that are more connected to the main streets have seen more upheaval from development. As the main streets are the connectors for the secondary and tertiary roads, commercial activities are prolific in the junctions of these streets. Hence, both permanent and temporary build elements play an important role in providing walkways for pedestrians through the pockets of space. Land use and functionality of that particular area influence the accessibility behaviors of pedestrian movement, and this movement is controlled by the urban structures. To support the movement patterns, nodes and squares constitute important determinants by which a city can be recognized and understood (Lynch, 1960). Although the township has number of nodes and connectors, we have focused on only two important nodes that are major contributors to the traffic system and have influence on the pedestrians and specified land uses. Both of the chosen nodes are in the commercial area, and each of them has its own distinctive characteristics.

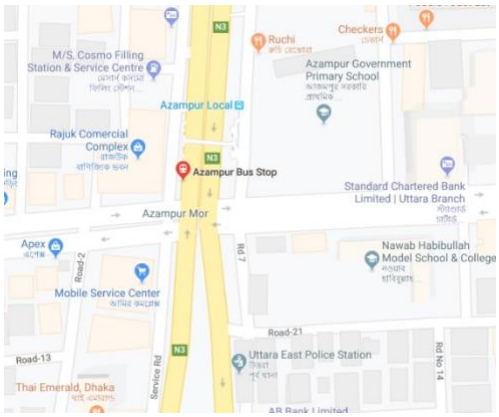
- Node -01: -The first node we consider is the Robindro Sarani and Dhaka – Mymensingh Road intersection.

  It is one of the major thoroughfares to the neighborhood from the primary road, and a place where numerous commercial activities occur.

- Node -02: -The second node is at the intersection of Shonargoan Janapath and Garib-E –Newaz Ave. It is also an important thoroughfare for traffic, and, as Uttara is expanding westward, major pedestrian and vehicular movement occurs here, along with development of multiple facilities of functional uses. Significant unplanned ad hoc development can be seen there.

Figure 5

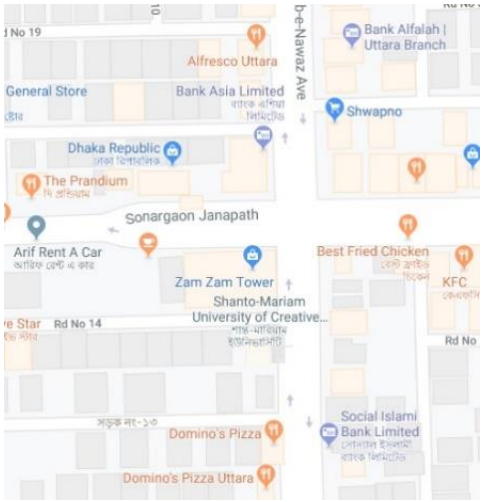
Node 01 intersection (Google map)



Note. From *Google Map* by Google, n.d., https://www.google.co.th/maps. Copyright by Google.

Figure 6

Node 02 intersection (Google map)



Note. From *Google Map* by Google, n.d., https://www.google.co.th/maps. Copyright by Google.

These junctions of paths usually create the juxtaposition of meeting places, commercial and recreational zones home to many activities. In both areas, commercial street activities to serve the pedestrians are concentrated on the nodes. These activities occur on the pathway of the local pedestrians coming to access public transport or transient commuters just exiting such transport and trying to reach another destination. This is a consequence of densely built up areas of the city and a lack of open public places. Because of this, domestic semi-private and community spaces often spill over in to streets, which, in addition to

being transitory spaces, are the first level of social space in the public domain.

Both nodes are centers of social activities. They are also the centers of seasonal huts, bazaars, labor market, rickshaw and auto-rickshaw stands. Interesting and lively spaces have nodes of activities at a maximum distance of 300m along their length (Alexander, 1987). (Figure 7)

The socio cultural character of Dhaka is a fundamental part of its morphological aspects. Usually in Uttara residential area, the roads and streets provide a framework for the individual plots and allow access to those plots. The main problem is the accessibility -- specifically, the concept of door-to-door mobility by various modes of transportation that have various speeds and often occupy the streets in certain manners. As more people become dependent on transport for their door- to-door mobility, the inclination to improve the lanes becomes more focused on upgrading the road systems rather than creating or widening walkways or providing urban street furniture. In closely interwoven areas, the streets are universally seen as areas for public circulation, commercial activities, and recreation (Krier, 1991). This is particularly true for Uttara and many other oriental societies in Dhaka. These are spaces for over spilled domestic activities that often provided means of socializing. (Figure 8)

Figure 7

Node scenario

Figure 8

Nodes are occupied by the rickshaws waiting for potential commuters

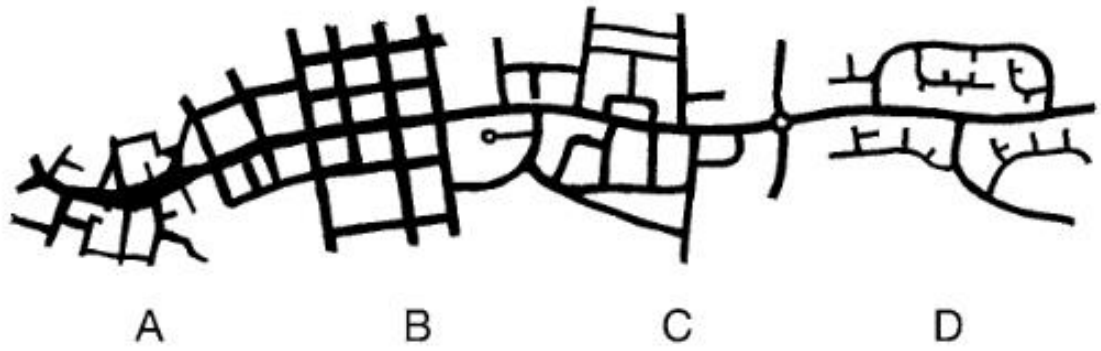
MOBILITY PATTERNS AND SPACE USAGE

The purpose of pattern classification is to distinguish between different types of patterns relating to desired formation of urban streets. Each typology of street -- the old town with traditional street type, the new town with design formation of streets, and even an organic type -- offers a distinct view of movement towards destinations. The point A to point B journey does not necessary follow an uninterrupted route; rather, it is common that it may halt at point C (and many others). Not adhering to strict travel modes, we can look at how the street systems in Dhaka can fit into systematic classification system.

The ABCD typology, as described by Stephen Marshall, was developed with the intention of identifying typical street patterns that are encountered in different urban analysis. (Figure 9)

Figure 9

ABCD typology as transect



Note. The four types are presented as if extending out from the core of a settlement (left) to the periphery (right). Not all types are necessarily present or in order; but normally, where present, the A-type would be the core and the D-type at the periphery. From *Streets & patterns: The structure of urban geometry*, by Marshall, S., 2004, Routledge. Copyright 2004 by Marshall, S.

The A-type is typically the core area of the city, usually labeled as an historic core. The angularity of the roads in multiple directions generates rudiment radially. These are the characters that give the streets and nodes the enclosure identity. Mobility on the streets is a more apparently walking-friendly environment than friendly to vehicular movement. Streets here represents culture, and even differ the typologies from one to another.

The B-type is typical of planned extensions or newly founded settlements. These are usually transitory spaces, and the movement here is usually mixed in multiple dimensions. The transitory spaces of the city gives dominance to four-way perpendicular junctions and to bilateral directionality with the formation of a grid pattern.

The C-type is the perhaps the most general type, and may be found at various positions in a settlement, but most characteristically astride an arterial route or a whole settlement along a radial route.

The D-type is typical of modern hierarchical layouts, and is often associated with curvilinear layouts of distributor roads forming looping or branching patterns. They usually have a hierarchy of roads, and the main pedestrian-related activities are at different junction points.

The 4 typologies are not necessary present in a single city. In some planned settlement type, there will be no type A patterns, whereas Dhaka city has a unique mixture of A & C types. The old town illustrates a unique combination of

pedestrian and non-motorized modes of movement, and new Dhaka follows more of a distance mobility pattern. To go to CBD or to an office, other than by using private vehicles, the city is more concentrated towards pedestrian mobility. Nodes and intersections are mostly occupied by the pedestrians who wish to avail themselves of a bus or an auto rickshaw. As we can see, the X and T junctions are attractive for occupants wishing to establish a business in order to catch potential customers from multiple sides. That creates a disturbance in the nodes, and the movements are relatively haphazard. The variety of block shapes in the corners and differences in sizes, and the curvilinear arrangement of the streets combine to create the desired patterns. A suitable form of pattern that easily demonstrates these features is a kind of organic pattern with a differentiation of street types based on different modes and speeds.

The selected nodes 1 & 2 are considered to belong to the B category in which the nodes are significant points of terminus or interchange. It also suits small scale pedestrian paths through space, where the paths are articulated into separate trajectories from point to point. In these cases, the X junctions are the points of focus, and the lines of movement – which may not correspond to distinct pieces of infrastructure – are only important insofar as they represent relationships between the nodes (Marshall, 2004). In street networks, it is often the hierarchy of routes that is the principal concern. The junctions and intersections are effectively by-products of routes meeting or crossing. Significantly, the lines of movement have continuity through nodes, and the differential continuity creates a structure of through passage and sidewalks. The graphic representation of the mobility is not constant in a given place. Rather it changes in nature according to the functional usage of the space. Therefore, it cannot be defined as belonging to a certain pattern type; rather, the continuity of the routes may be interfered with and a representation of vivid patterns of functional mobility may be built.

Figure 10

Mobility is guided by the public transport and surrounding settlements

URBAN FORM ANALYSIS OF TWO NODES

In this section, the two nodes are compared on the basis of urban form elements present in the intersections. The visual impact of land use and activities along the streets and intersections encourage or discourage pedestrian movement.

The number of factors that shape the pedestrian activities in the intersection of the nodes include,

a) Population density
b) Land use
c) Block size and intersection density
d) Street patterns and connectivity

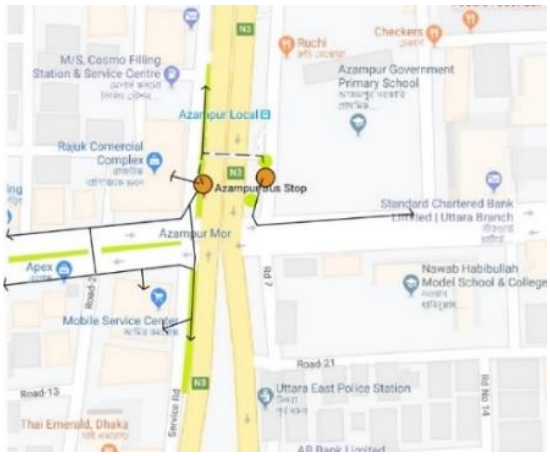
Node-01, the Robindro Sarani and Dhaka – Mymensingh Road intersection is strongly transit-oriented, with two out of four individuals confirming access to transit as their primary purpose for visiting. The remaining two confirmed that shopping was their primary objective. The node attracts all types of pedestrian traffic, including males and females of various professions, including students, because of its diverse land use. As Uttara is a satellite town, this intersection acts as a major transit hub for the passengers, attracting a large number of people. High density and mixed-use spaces saturate the node with various modes of

transport. However, the vertical volumes that shape the node are crucial to the visual impact on an individual. In Node -01, the street has predominant commercial land activities; Building facades are large, and minimal variations in vertical masses create a boring and monotonous look. In contrast to the unexciting backdrop, the node itself is vibrant due to hawking activities that spill onto the road and reduce the effective walking space.

Street widths, including the service road that runs parallel to the Dhaka- Mymensingh road, vary from 10m to 15m. However, the main roads from south to north act as a central spine that divides the sectors and defines access points.

Figure 11

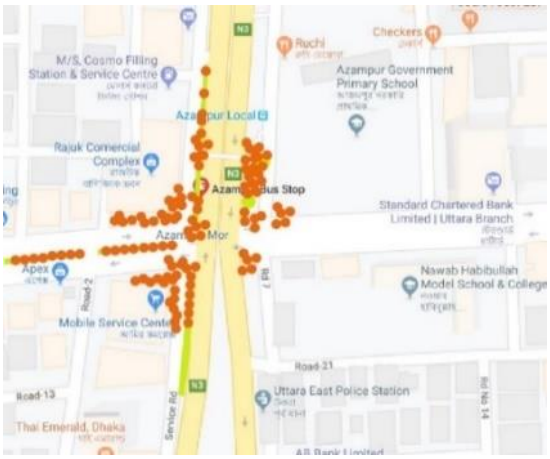
Accessibility point for the pedestrians



Notes. Showing accessibility point for the pedestrians (the hotspot zone for intermingling and stop over point is also measured)

Figure 12

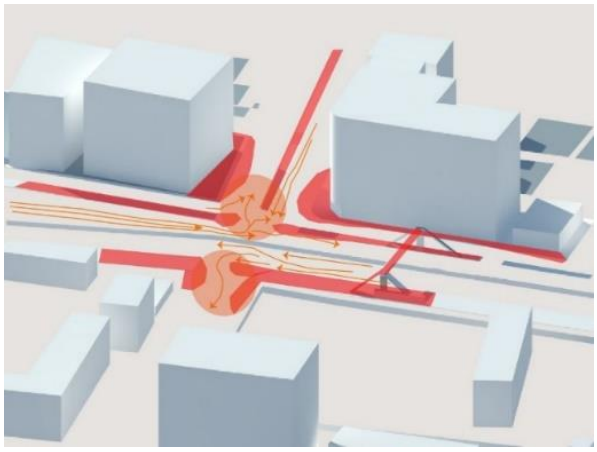
Pedestrian stop over points



Notes. Showing pedestrian stop over points. One dot measures 5-7 individuals (calculated between 8:00am – 8:00pm).

Figure 13

An axonometric of the surround street along with entry points



Notes. Showing an axonometric of the surround street along with entry points to the sectors. This is crucial for understanding the pedestrian accessibility from the neighborhood area to the nodal point.

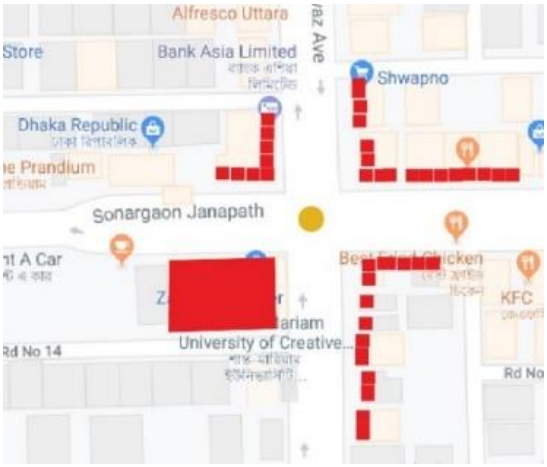
In the node intersection, the northern side consists of a massive commercial complex. The land use comprises mixed use and mostly serves middle income or lower middle-income groups of people. Since the transition area to access public transport is mostly reserved for middle and low income groups of people, the land use and the hawking on the street is mostly there to serve them.

The southern side of the node is also a commercial complex, mostly popular for jewelry and sports items. There is a mix of merchandise on the ground floor, including the food shops that attract passersby and students. Above is the four-storey house, the RMGF (Readymade garments factory). Before or after working hours, the streets are filled with laborers from this more private territory. Most of them depend on walking. Their points of destination are mostly from the work place to the bus stop in the node, or walking in multiple directions to their homes. During school hours and the evening time, people fill the walkways and the streets due to poor management of the infrastructure facilities.

On the eastern side of the node, the morning is reserved for the labor market and office goers who need to access transportation to work. This is a rather clean territory where land use and the surrounding block comprises an educational institute, and foot traffic is minimal compared to the other side of the node.

Figure 14

Shonargoan Janapath intersection



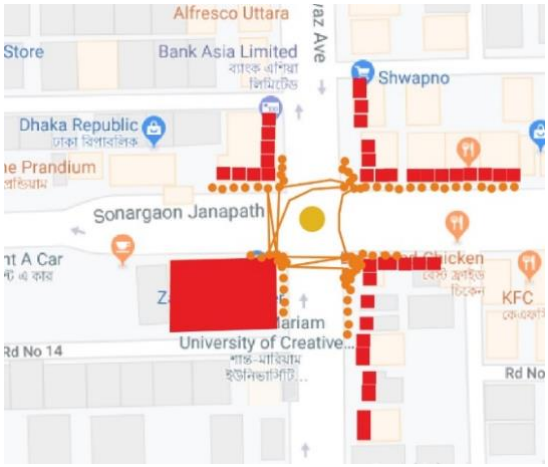
Notes. Shonargoan Janapath intersection showing small parcel block shop front used as cafés/restaurants, or shops selling inexpensive products and accessories. The upper floors are primarily reserved for restaurants, offices and residences.

The second node is an agglomeration of various sectors in both N-S & E-W directions. In contrast to the first node, the blocks are smaller and more vivid. The vertical mixing of uses such as apartments or residential areas over retail shops adds visual variety. The small block sizes encourages connectivity and breaks the monotony of pattern and changes. Small areas comprising multiple functions promote various groups of people to linger and frequent pedestrian stoppage can be mapped here.

Mixed land use development improves accessibility to the vivid characteristics of functional diversity. This particular node attracts middle and high income groups of people as Node-02 is used as a transition space for people to move along either direction to where the fashion stores and café/restaurants are located. Towards the western node, a newly built shopping complex adds a dimension to the pedestrian movement pattern in the node.

Figure 15

Pedestrian mobility mapping



Notes. Pedestrian mobility mapping in the intersection of Node 02. Each dot represents 3-4 individuals.

BLOCK SIZE AND INTERSECTION CONFIGURATION OF THE TWO NODES

A node is a formation of streets; that is, blocks and the streets are the fundamental structures of a node. A well laid out pattern of blocks at an intersection and good land use allow for supportive transit-oriented facilities and buildings act more as an edge to the street than as freestanding objects in the space (Owens, 1993).

In Node -02, at the Sonargaon Janapath intersection, small blocks assist in the easy navigation of pedestrians. Hawking is evident in the intersection. However, due to the vivid nature of land use on the ground floor, hawkers are not as prominent as in Node -01. The shoppers are more comfortable getting inside the stores, rather than buying from vendors on the streets. The user class is different and the brand shops usually don't allow hawking in front of their stores. The smaller the average block, more the vibrant facades break the monotony of the space. The relationship between the node intersection, the building blocks and travel patterns is a more complicated. In Node -02, the average block height is 5 -7 stories, whereas, in Node-01, the average block height is 8-10 stories. In both nodes, the travel time in the nodes is

proportionally much slow for vehicles than the pedestrians. Higher intersection densities also correlate with increased transit area, where the node is crucial for motorized mobility. Commuters are presented with a great variety of potential modes of transport.

In Node-01, the block sizes are large, and they are associated with reduced land use and a smaller variety of activities. The bigger the average blocks, the fewer the possibilities for the pedestrians to exist in the urban pocket spaces. Consequently, the moving speed of a pedestrian is much higher than in small block surroundings. Since there are no designated streets for shopping activities, hawking is largely evident along the long span of side streets, posing interruptions to the movement of pedestrians. The high volume of vehicular traffic as well as unplanned locations of bus stoppage cause many problems such as traffic congestion, inadequate parking, barriers between motorized and non-motorized modes of transport, jaywalking, noise and pollution.

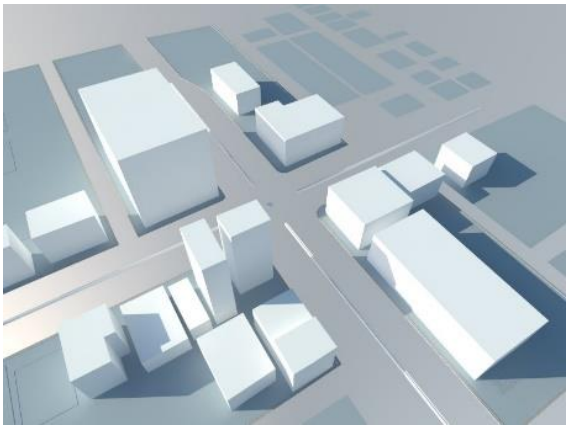
Building height is crucial for any node as buildings tend to provide shade. Movement of people on the street to reach a destination while using a node can bring the node alive in its character. The higher a building is, the more it can create a sense of enclosure to the surroundings and encourage shopping activities for the commuters. In Node-01, the lack of alternate routes available to reach destinations restricts the traffic to the main street. This creates more collisions within the node, harming its image.

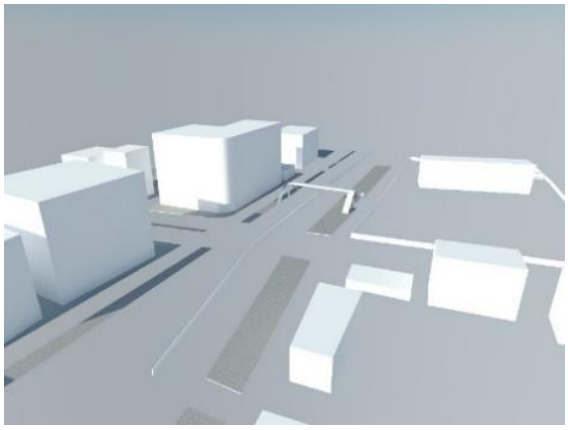
Figure 16

Node condition in the study area

a)

b)





c)

Notes. a) Non-motorized vehicular movement poses a threat to the respective nodes. b) Block size is much larger in node-01 compared to node-02, which is more vivid. c) Study model shows the spatial enclosure and H/W ratio.

Due to defects in the physical condition of the streets, the contradicting mix of travelers, and the magnitude of foot traffic flow, Node-01 regularly sees serious disturbances affecting the image of the street. A unifying aspect of different buildings in Node-02 is that they constitute a street façade with different elements and architectural features that create chaos rather than coherent features. In Node-01, on the other hand, as the parcel/buildings are large, their feature creates a homogeneous yet monotonous visual impression. In both nodes, sidewalks are encroached upon by parking or the extension of retail activities that discourage pedestrian movement.

OUTCOME

There are numerous problems for people's mobility within the urban spaces or Uttara. The most serious causes of the problems are the retailers, traders and hawkers that spread their trade goods on the walkways, eventually reducing the effective width of those walkways. People are forced to walk on the streets due to the interrupted and broken nature of the existing walkways, thus creating severe safety hazards.

Other significant causes of limited mobility are the construction materials occupying the streets, rickshaw stands, illegal parking, garages, etc. Another problem is people making their living on the walkways. This is a serious issue as this creates illegal occupancy on roads, but people from the surrounding built environment take advantage of it.

There is a designated place for bus stoppage in Node-01; however; due to the volume of pedestrian intensity right in front of the node, buses stop right at the intersection and create blockage in the entry/exit points to the secondary streets.

It is observed that in both nodes, there is a lack of street furniture and civic amenities. Apart from the sidewalks, a continuous dedicated pedestrian path is missing and can be introduced within the setbacks of the urban blocks. Urban green is visually nonexistent and can be provided in the node to discourage jay walking by pedestrians. Ground floors should be continuous as active building frontage that should be linked with green passages and shade for the streets. In some areas, elevated walkways can be installed and multiple entry and exit points should be encouraged to decentralize the floor traffic. To ensure a clean node with disciplined foot traffic, considerations must be given for a comfortable walking experience; pedestrians should be protected from rain and sun. Therefore, shades and shelters should be in the plans when designing pedestrian pathways. Enclosure like archways, arcades, building overhangs, extension galleries, and terraces should be incorporated within the building designs. Selection of shade trees and location of plantings is also important to ensure sky exposure along with the wind flow at the pedestrian level. However, the selection of trees, and

establishment of a standard with detailed requirements is well beyond the scope of this research.

Intersections must provide direct, intuitive pedestrian crossings. In Node-01, a footbridge for crossing the street is very effective and useful. In contrast, Node-02 represents a bare scene with no designated crossing areas. A designated crossing in both nodes should reflect pedestrian desire lines and avoid detours. The position of the bus stop should always leave clear space for walking behind the shelter.

From the urban form analysis, it is clear that there are fundamental differences in urban form configuration between the two nodes in terms of the physical structures and the mobility patterns. Urban form elements in Node-02 are more influential than those in Node-01, which is more transit oriented. Therefore, the concept of inclusive design must be adopted in the case study nodes; they cannot be prototyped. The solution should come from the physical pattern that guides the mobility within the node and the series of interventions that specifically applies.

CONCLUSION

Urban structure plays a key role in providing available paths for pedestrian flows through urban areas (Anas et al., 1998; Hillier, 1996; Kim, 2017; Voulgaris et al., 2015). Public spaces, sidewalks, and street crossings- all influence the direction of crowd movement, along with the surrounding conditions that have an impact on people making decisions about which access path to select (Metrolinx, 2016; Nakamura, 2016). Keeping that in mind, we need to focus on pedestrian mobility features and their activities within the built environments and implement design guidelines. The concept of adopted deign from the world cities cannot be embraced in this scenario in cities like Dhaka that cannot be retrofitted because of different trajectories in the system and physical nature of a space.

Due to the vivid nature of functional land use, nodes cannot be limited to similarities; rather, they should be addressed to create coherence with the existing diversity. Further, the goal should be to maintain the essence of the street pattern, with priority given to pedestrians along with a focus on ease of access to public transport, which would lead to inclusiveness. The functional pattern of nodes varies and is very much contextualized within cities. Though, only two nodes were studied, further understanding of the movement patterns in them should enabled development of concepts to improve the image of the nodes and the surrounding streets. To extend this effort to the city wide level, more nodes could be investigated.

REFERENCES

Alexander, C. (1987). *A new theory of urban design*. Oxford University Press. https://hdl.handle.net/2027/mdp.39015012221381?urlappend=%3Bsignon=swle:https://shibidp.cit.cornell.edu/idp/shibboleth

Anas, A., Arnott, R., & Small, K. A. (1998). Urban spatial structure. *Journal of Economic Literature*, *36*(3), 1426–1464. http://www.jstor.org/stable/2564805

Bangladesh Bureau of Statistics. (2011). *2011 Population & housing census: Preliminary results*. Dhaka: Bangladesh. https://catalog.ihsn.org/index.php/catalog/4376

Bentley, I., Alcock, A., Murrain, P., McGlynn, S., & Smith, G. (2013). *Responsive environments: a manual for designers*. Architectural Press.

Berman, M. (1988). *All that is solid melts into air: The experience of modernity*. Penguin Books. https://catalog.hathitrust.org/Record/003151690?signon=swle:https://shibidp.cit.cornell.edu/idp/shibboleth

Bierlaire, M., Antonini, G., & Weber, M. (2007). Behavioural dynamics for pedestrians. In K. W. Axhausen (Ed.), *Moving through nets: the physical and social dimensions of travel* (pp. 81–105). Emerald Publishing Limited.

de Smith, M. J., Goodchild, M. F., & Longley, P. A. (2007). *Geospatial analysis: A comprehensive guide to principles, techniques and software tools*. Troubador Publishing Ltd.

Hillier, B. (1996). Cities as movement economies. *Urban Design International (London, England)*, *1*(1), 41–60. https://doi.org/10.1057/udi.1996.5

Imon, S. S. (2016). Urban design and quality of life in Dhaka. In M. Rahman (Ed.), *Dhaka: An Urban Reader*. Dhaka: University Press Limited.

Jacobs, A. B. (1993). *Great streets*. MIT Press.

Kim, C. I. (2017). *Urban spatial structure, housing markets, and resilience to natural hazards*. Massachusetts Institute of Technology.

Krier, R. (1991). *Urban space*. Academy Editions.

Laube, P. (2009). Progress in movement pattern analysis. In B. Gottfried & H. Aghajan (Eds.), *Behaviour Monitoring and Interpretation - Ambient Assisted Living,* (pp. 43–71). IOS Press. https://doi.org/10.3233/978-1-60750-048-3-43

Lynch, K. (1960). *The image of the city*. MIT Press.

Mahmud, S. M. S. (2009). *Identify the deficiencies of landuse-transport development in Dhaka City*. Bangladesh University of Engineering and Technology.

Marshall, S. (2004). *Streets & patterns: The structure of urban geometry*. Routledge.

Metrolinx. (2016). *GO rail station access plan*. http://www.metrolinx.com/en/regionalplanning/projectevaluation/studies/GO_Rail_Station_Access_Plan_EN.pdf

Nakamura, K. (2016). The spatial relationship between pedestrian flows and street characteristics around multiple destinations. *IATSS Research*, *39*(2), 156–163. https://doi.org/https://doi.org/10.1016/j.iatssr.2015.08.001

Owens, P. M. (1993). Neighborhood form and pedestrian life: Taking a closer look. *Landscape and Urban Planning*, *26*(1), 115–135. https://doi.org/10.1016/0169-2046(93)90011-2

Rajdhani Unnayan Katripakkho. (2015). *Draft Dhaka structure plan (2016-2035) report*. Dhaka, Bangladesh.https://www.rehab-bd.org/img/home_attach/Dhaka Structure Plan (2016-2035).pdf

Voulgaris, C. T., Loukaitou-Sideris, A., & Taylor, B. (2015). Planning for pedestrian flows in rail rapid transit stations: Lessons from the state of current knowledge and practice. *The Journal of Public Transportation*, *18*, 1–14.