

Impacts of Pedestrian Traffic on Urban Form: A Case of Historic Core of Kathmandu

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Abstract

Pedestrian movement is one of the most environmentally friendly modes of transportation. Pedestrian activity helps to preserve the environment by limiting the usage of automobiles that pollute the air and noise. From an economic standpoint, increased pedestrian traffic in the streets means more possibility for increased business. Pedestrian transportation also promotes engagement and communication, as well as social equality and fairness. As land use changes, so does the dispersion of pedestrians. This research focus on studying the impacts of pedestrian traffic on the urban form in historic core of Kathmandu. Kathmandu is rapidly urbanizing municipality where the pedestrian traffic has increased in even faster pace. To gain insight into the current scenario of study area, both qualitative and quantitative analytical methods were used using the data collected via interviews with key informants and questionnaire survey and pedestrian count at 8 different stations in the study area. Various elements with respect to urban form at study area were analyzed. The study has drawn conclusion and recommendations regarding the urban form and pedestrian traffic management for the municipality, and for the urban areas that are in stage of rapid urbanization.

Keywords

Pedestrian, Pedestrian Traffic, Urban Form, Pedestrian Traffic Management

1. Introduction

Pedestrian infrastructures, facilities, and services are frequently overlooked in municipal planning and finances in Nepali cities, despite the fact that a large proportion of trips are conducted on foot. Inadequate pedestrian design has a number of negative outcomes, the most noteworthy of which are avoidable deaths and injuries. Even when traffic flow rates are identical, pedestrians in poor nations are far more likely to be wounded or killed than pedestrians in industrialized ones[1].

Traditional cities in the Kathmandu Valley were built for strolling and offering social spaces for people to meet. Many people in the Kathmandu Valley still walk to get around on a daily basis. According to a recent research conducted by the Ministry of Physical Infrastructure and Transport and JICA, walking is the preferred form of transportation for 40.7% of people[2]. In the previous two decades, however, the percentage of people who walk has decreased by more than 23% [2]. This is mostly due to the fact that the

accepted plans, regulations, and infrastructure development are nearly entirely vehicle-friendly, deterring people from walking or cycling. Increasing traffic congestion, growing reliance on imported fossil fuels, high levels of air pollution, and a substantial increase in road deaths, particularly among pedestrians and cyclists, have resulted from increased motorization and vehicle-prioritized infrastructure[3].

Due to unmanaged urban growth, chaotic construction, and an increasing number of vehicles in Kathmandu, the lively and pedestrian-friendly streets of the Malla period and the unique streetscape of the Rana period, including streets in planned and haphazardly developed areas, are being rapidly transformed. On all sorts of roadways, this has damaged the physical shape, reduced social activities, increased accidents, and lowered pedestrian comfort. The present legislative and administrative frameworks of the urban development and traffic management agencies are unable to handle these detrimental repercussions. Pedestrian mobility has been discouraged, the cityscape has been deteriorated, and

public areas have been supplanted by vehicles. This has added to the congestion of pedestrians and cars in already congested regions[4].

In addition to the safety issues, poor pedestrian design has additional negative repercussions. Lack of physical mobility, for example, might stifle economic and social mobility by reducing inhabitants' time and energy spent on employment, families, studies, and other productive activities. Furthermore, a city's lack of adequate pedestrian infrastructure may be highly costly in the long term. There are opportunity costs associated with lost tourist and investment possibilities, in addition to the needless expenses associated with accidents and hampered economic mobility[1].

2. Problem Statement

Increased traffic congestion and road accidents, as well as increased air and noise pollution, have resulted from the rapid rise in population and vehicles, as well as densification of restricted metropolitan areas, including uncontrolled construction change. In many respects, the previous form and purpose of the streets has also altered. Pedestrian traffic in Kathmandu Valley have increased significantly across all urban areas due to pressures of urbanization. The urban street and roads in Kathmandu Valley are not pedestrian friendly in the absence of proper planning for pedestrian.

3. Research Objectives

The primary objective of this study is to investigate the relationship between pedestrian traffic and urban form. The specific objectives of this research are:-

- To determine the implication of pedestrian traffic on urban form.
- To recommend pedestrian traffic management in present and future scenario.

4. Literature Review

4.1 Pedestrian Traffic

On the basis of average pedestrian area occupancy, pedestrian traffic volumes and queuing relationships may be established. The amount of pedestrian traffic gives the essential design parameters. It explains how

an analysis and set of principles were utilized to create a pedestrian-friendly plan[5].

Flow Volume It is the number of traffic units that pass through a given place in a given amount of time.

4.1.1 Principle of Pedestrian Flow

Pedestrian features include the ability to cross a pedestrian traffic stream, travel in the opposite direction of primary pedestrian flow, navigate without conflicts or changes in walking pace, and the time it takes for pedestrians to cross a signalized and unsignalized crossing[6]. The comfort, convenience, safety, security, and economics of the walkway system are all environmental variables that influence pedestrian traffic. Weather protection, climate control, shelters, and other pedestrian facilities are all comfort elements. Walking distance, pathway directness, slopes, sidewalk ramps, directional signage, directory maps, and other characteristics that make pedestrian travel simple and straightforward are all convenience considerations.

4.1.2 Pedestrian Walking Speed

It is proportional to the number of senior pedestrians in the walking population. On sidewalks, the average walking pace is 4 feet per second if up to 20% of the walkers are old. When older persons account for more than 20% of total pedestrians, the average walking pace drops to 3 feet per second. Furthermore, a 10% or greater walkway enhancement lowers walking speed by 0.5 feet per second[7].

4.1.3 Pedestrian Type and Trip Purpose

The mean or average walking speed of a group of walkers is used to analyze pedestrian flow. Due to trip intent, land usage, group type, age, and other considerations, there can be significant variations in flow characteristics within any group. Pedestrians on their way to and from work, who use the same facilities every day, walk faster than shoppers. People who are older or extremely young move at a slower pace than other groups. Not only can shoppers travel slower than commuters, but they can also reduce the effective walkway by pausing to sight shop and carrying items[1].

4.2 Elements of Urban Form

The word "urban form" can simply be used to describe the physical qualities of a city. Urban form

has been described as the spatial arrangement of permanent components at the city or regional scale[8]. Density, Transportation Infrastructure, Housing Type, Land Use, and Layout are the five broad and interrelated components that make up a city's urban form.

Density It is a spatially-based, subjective assessment of the number of people (dwelling) in a particular region; a social interpretation based on individual attributes that may change from one resident to the next. [9].

Land Use It describes the environment's many functions. The primary land use in the urban environment is often residential, but a viable urban area also includes industrial, retail, offices, infrastructure, and other uses.

Accessibility and Transport Infrastructure The area that inhabitants and users may access, as well as their ability to access locations, services, and amenities that are outside their immediate vicinity[10].

Layout The physical organization and configuration of features of streets, blocks, and buildings, typically referred to at the street size, such as grid or tree-like (cul-de-sac) street patterns, is known as street planning.

5. Methodology

To achieve the stated objectives, suitable research paradigm needs to be associated with the study. The nature of research requires both qualitative and quantitative research approaches (viz. Pragmatic Paradigm). Here, epistemological position is interpretivist where there are multiple subjective interpretations of social reality. Initially, literature review and case studies were done to gather the required background knowledge. To gain insight into the current scenario of study area, both qualitative and quantitative analytic methods was used and necessary data was collected via interviews with key informants and questionnaire survey. The selected key informants were architects, urban planner and local residents were interviewed upon different facets of pedestrian traffic in study area. The pedestrian impact on urban form – streets and side walks, building usage type, building facade and storey were determined on the basis of literature review and observation at the site.

Selection of location of station was carried out on the basis of direction of pedestrian movement. For pedestrian counting along the direction of traffic, 8 different stations were selected. Manual pedestrian count were done to collect a range of data for pedestrian flows. As per the observed data on each predefined location the average peak pedestrian traffic data were determined.

Structured and semi structured Questionnaire survey of 73 pedestrians is carried out by random sampling regarding origin and destination of the trip, trip purpose, reasons for choosing pedestrian travel mode, route selected, reasons for the route selection, problems faced, opinion on street vendors, opinion on pedestrianization. Direct and participant observation on site is carried out for land use street, appearance, formal and informal activities, parking, street character (physical, social, cultural) and street infrastructure. Street width, Building heights, façade, building use is noted on field by measurement and observation. Block size, connectivity, alternate pathways is studied on maps.

6. Study Area

The study area of this research is the area of Ason-Kathmandu Durbar Square where there is high density of people, variety of travel choices and variety of landuse (Residential, Commercial, Institutional, and Heritage Site).

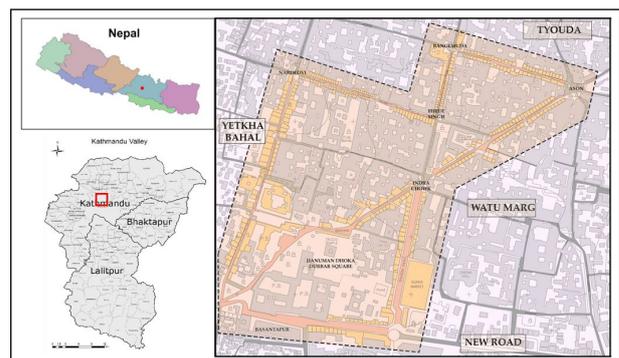


Figure 1: Location of study area

The historic marketplaces and commercial centers of Ason and Indrachowk are located in the heart of Kathmandu on the small streets of Ason and Indrachowk. Ason is a six-street intersection where anyone might be overwhelmed by the activities that take place there from sunrise to dusk. One of the alleys goes to the Hanuman Dhoka Palace in

Indrachowk. Metal containers, ceramic pots, vegetables, cereals, clothes, handicrafts, pashminas, carpets, and other items are sold on both sides of the street. Rickshaws, motorcycles, cyclists, street merchants, and pedestrians all appear to be rushing to get somewhere. Makkhan, Indrachowk, and Bhedasing streets. Traditional streets like as Kilagal and Phyaphal may be found near Ason and Basantapur Durbar Squares[11].

The vegetable markets are located at Bhedasing Chowk and Kilagal Street. Makkhan is mostly a business district that connects to Kathmandu’s Durbar Square. After Ason, which is traditionally a center for the selling of blankets and fabric, Indrachowk is the busiest market area, and there are typically numerous traders on the platforms of the Mahadev Temple. The Phyaphal Street also goes straight to the Basantapur Durbar Square. As a result of their near proximity to Assan’s historic marketplaces and business districts, as well as the world heritage site Kathmandu Durbar Square, and the dense residential sector of the urban centre, these streets have become highly busy and significant commuting routes. Because of the constant flow of people, two-wheelers, and four-wheelers throughout the day, these streets are bright and highly crowded. These streets were built for pedestrians in the past and complemented the ancient arena wonderfully. Two-wheelers, private cars, public autos, school buses, and large trippers now share these roadways with pedestrians. Furthermore, the high pedestrian flow encouraged a significant number of street vendors to set up shop on the sides of these streets, as well as local merchants, leaving very little room for people to pass freely[11].

6.1 Pedestrian Count Stations

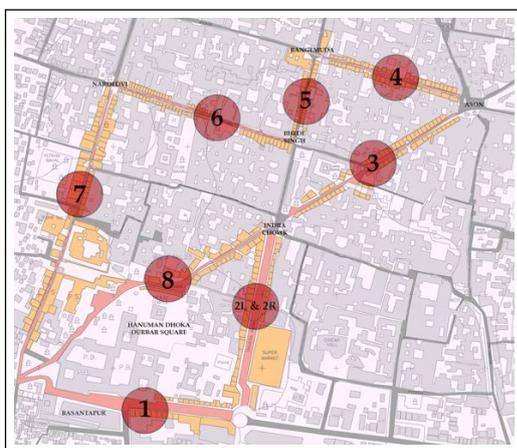


Figure 2: Location of pedestrian count stations

The movements of pedestrians along the direction of roadway length have been considered for analysis. The major data collection stations have been identified as follows:

- Station 1** Bansantapur Dabali
- Station 2** Sukrapath(Left and right of footpath)
- Station 3** Machhindra Bahal(Ason–Indrachowk)
- Station 4** Ugratara Mai temple(Ason-Bangemuda)
- Station 5** Ganesh Temple(Bangemuda-Bhedasing)
- Station 6** Kilagal(Bhedasing-Naradevi)
- Station 7** Santaneshwor Mahadev Temple(Naradevi-Basantapur)
- Station 8** Mahadev Temple(Basantaur-Indrachowk)

Pedestrian count is carried out for 11 hours(from 8AM to 7PM) of duration for each 15 minute of time interval.

7. Data Analysis

7.1 Distribution of Pedestrian Volume

7.1.1 Total Pedestrian volume distribution around kathmandu Durbar Square

Stations	Total Pedestrian Volume
	From 8AM to 7PM
Station 1	19503
Station 2(L&R)	26780
Station 3	21120
Station 4	12654
Station 5	12576
Station 6	12236
Station 7	9149
Station 8	22521

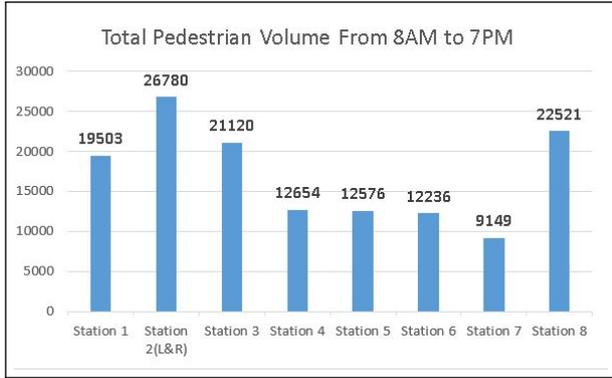


Figure 3: Pedestrian throughput

Station 2 (Shukrapath) has the highest amount of total pedestrian throughput during eleven hours period from 8AM to 7PM and is followed by Station 8 (Mahadev Temple), Station 3 (Machhindra Bahal), station 1 (Basantapur Dabali) and the lowest one being station 7 (Santaneshwor Mahadev Temple). However, the hourly distribution of pedestrian volumes around these locations can be assessed using the following charts and graphs.

Time Interval	Pedestrian Volume In Area around Kathmandu Durbar Square									Total Count
	Station 1	Station 2(Left)	Station 2(Right)	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	
8:00-9:00	972	467	353	1329	761	751	1130	662	1785	8210
9:00-10:00	1981	547	392	1122	933	888	1018	970	1906	9757
10:00-11:00	1942	759	461	1237	980	873	921	927	1748	9848
11:00-12:00	1303	1077	699	1448	983	879	941	830	1495	9655
12:00-1:00	1962	1346	979	2074	1215	1134	1104	785	1552	12151
1:00-2:00	2297	1861	1551	2434	1062	1137	1062	624	2166	14194
2:00-3:00	2168	1885	1924	2498	1254	1194	1057	808	2341	15129
3:00-4:00	1946	2195	1496	2416	1201	1125	1167	750	2803	14299
4:00-5:00	1902	1580	1420	2077	1446	1467	1139	757	2294	14082
5:00-6:00	1396	1809	1314	2317	1315	1521	1236	904	2583	14956
6:00-7:00	2138	1505	1160	2168	1504	1607	1461	1132	2648	15323
Total	20007	15031	11749	21120	12654	12576	12236	9149	22521	

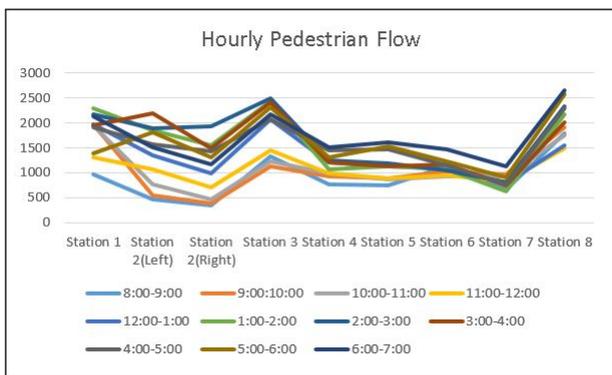


Figure 4: Hourly pedestrian distribution

From these diagram, it is evident that station 8 (Mahadev Temple) along Indrachowk-Basantapur segment has the highest pedestrian throughput followed by the pedestrian volume of station 3 (Machhindra Bahal) along Ason-Indrachowk segment.

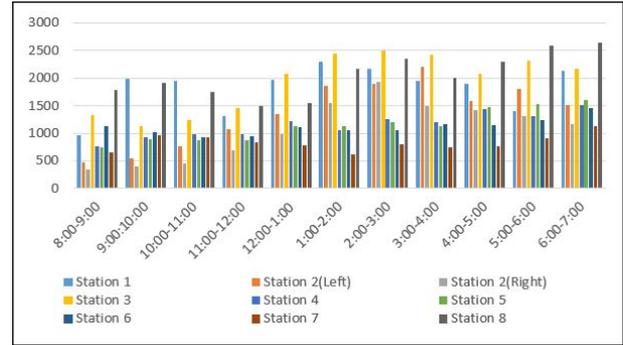


Figure 5: Pedestrian throughput at stations

7.1.2 Pedestrian volume distribution in each street

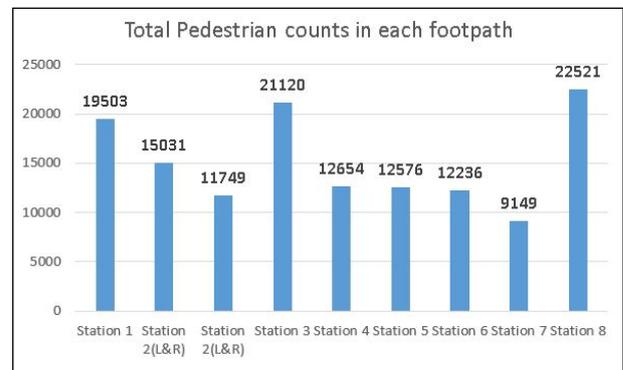


Figure 6: Pedestrian distribution in each street

It has been observed that total pedestrian volume in station 8 (Mahadev temple) along Basantapur-Indrachowk segment has the highest amount of pedestrian volume of 22,521 followed by the station 3 (Machhindra Bahal) along Ason-Indrachowk segment. Hence, it is clear that in terms of landuse, the religious area and shortcut diagonal route has the highest pedestrian throughput. This is followed by the mix commercial area like Ason which has the strong pedestrian volume.

7.1.3 Hourly Distribution of pedestrians in Streets

The sum of hourly distribution of pedestrian is found to be peak of 15,323 during the time interval of 6PM to 7PM, which is strongly followed by the volume of 15,129 during the time interval of 2PM to 3PM. Hence, the peak hour pedestrian traffic is established as 6PM to 7PM. This is in accordance with the public survey where the pedestrian tending to return home from shopping was during 4PM to 7PM.

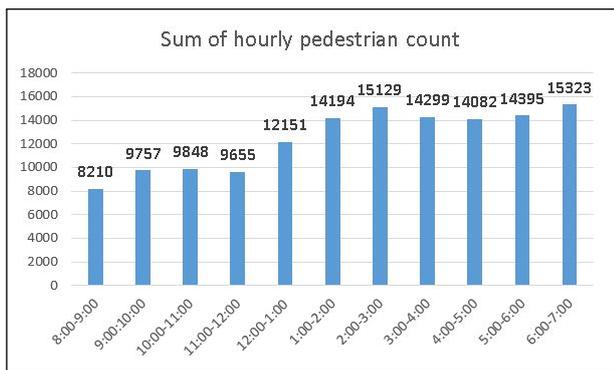


Figure 7: Hourly pedestrian count

7.1.4 Peak 15 minutes pedestrian volume distribution

According to the observation station, it has been identified that the highest 15-min pedestrian volume was at Station 8(Mahadev Temple) along the Basantapur-Indrachowk segment with total pedestrian count of 822 whereas the lowest 15-min pedestrian volume was found to be at station station 7(Santaneshwor Mahadev temple) along Naradevi-Basantapur segment.

Peak 15 minutes Pedestrian Volume Distribution		
Stations	Peak 15 min Count	Time Interval
Station 1	677	2:15-2:30
Station2(Left)	613	3:00-3:15
Station 2(Right)	547	1:45-2:00
Station 3	715	2:30-2:45
Station 4	441	6:30-6:45
Station 5	439	6:45- 7:00
Station 6	391	6:45- 7:00
Station 7	303	6:15-6:30
Station 8	822	5:30-5:45

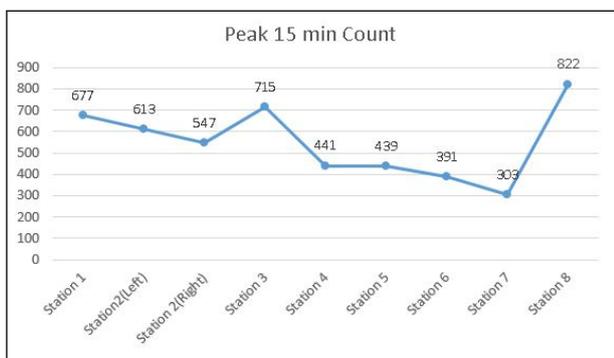


Figure 8: Peak 15-min pedestrian distribution

7.2 Analysis of Elements of Urban Form

7.2.1 Streets and Sidewalks

Kilagal, Bhedasing, Indrachowk, and Makkhan have stone-paved roadways with street widths ranging from 12’ to 25’. Makkhan and Kilagal have wider streets than the rest of the city. Phyaphal’s streets are black-topped, with street widths ranging from 10’ to 15’. Despite the significant pedestrian traffic and high speeds of two, three, and four wheelers, including carts and rickshaws, none of these roadways have a sidewalk.



Figure 9: Indrachowk-Ason Street

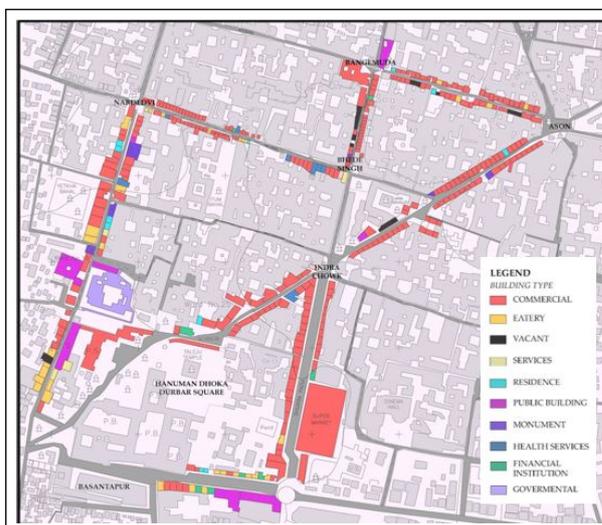


Figure 10: Building type at study area

Makkhan’s street are densely packed with shops and stores. The streets are stone-paved and free of potholes. Bhedasing and Kilagal have paved streets as well, although they are made of slick stones. Due to the widespread presence of potholes and damaged pavements, these streets are extremely hazardous for

pedestrians and cars. The ruined pavements at the intersection of Bhedasing chowk and Kilagal have exacerbated the street’s deterioration. Potholes and damaged pavements abound in Indrachowk, which serves as a rickshaw stop and a crossroads for five streets, causing chaos for pedestrians.

In Phyaphal, the state of the street is deplorable. The road is black-topped and riddled with potholes. The blacktop has been destroyed in numerous areas, creating a muddy road. As a result, the lack of maintenance is evident on this street. Drains are installed on both sides of the street, but they are not functioning properly.

7.2.2 Building heights and Building façades

As it is a historic highly inhabited residential district near to Kathmandu Durbar Square, most of the buildings have brick facades. However, due to modernisation, changes may be noticed in terms of building façade, construction material, building height, and building purpose.

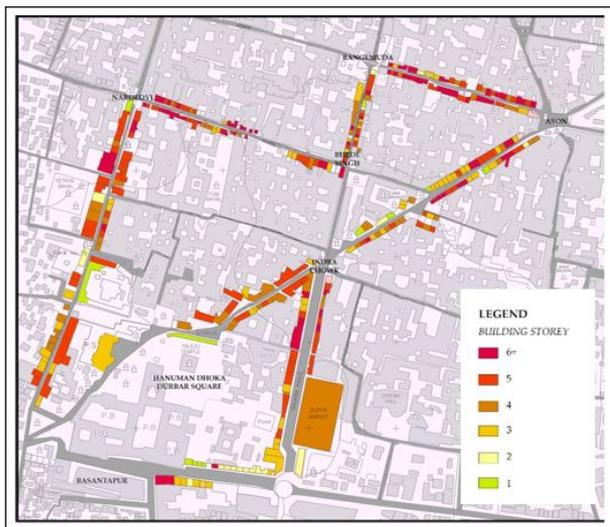


Figure 11: Building storey type at study area

Makkhan, a very commercial neighborhood that leads straight to Kathmandu Durbar Square, has a unique combination of traditional, neoclassical, and modern buildings with exposed cement plaster or brick facades. Buildings are typically 4–7 stories tall, with some reaching as high as 8 stories. As there are no sidewalks, the majority of the buildings are directly attached to the street; some are divided by the stairs and plinth of the structures. The lower floors of most buildings are utilized as stores, while the higher levels are used for business uses as well, with only the

topmost floors being used for residential reasons.

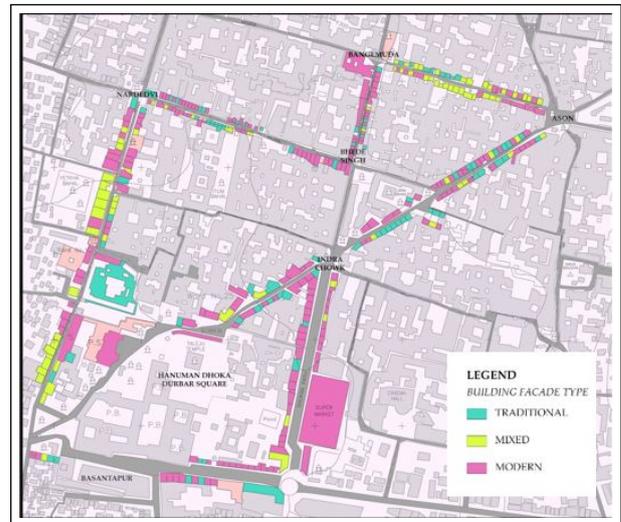


Figure 12: Building facade at study area



Figure 13: Building height and facade at Indrachowk Street

Similarly, in Indrachowk and Bhedasingh, one can see a mix of traditional, neoclassical, and modern 5-8-story structures with brick and cement plaster facades and the use of ground floor as a store. Buildings in Kilagal’s main street range in height from 4 to 8 stories, and include traditional,

Table 1: Condition of streets at urban Core

SN	Street	Street width	Street Pavement	Street Condition	Side walk	Potholes
1	Makkhan	12'-24'	Stone paved	Good	No	No
2	Indrachowk	13'-20'	Stone paved	Medium	No	Yes
3	Bhedasingh	15'-18'	Stone paved	Medium	No	Yes
4	Kilagal	18-22'	Stone paved	Medium	No	Yes
5	Phyaphal	10'-15'	Stone paved	Medium	No	Yes

neoclassical, and modern styles. Except for the usage of ground floor for commercial purposes, the majority of buildings are used for residential purposes. Some of the structures are in a condition of disrepair. Buildings on Phyaphal's street are mostly 4 and 5 stories tall, with just a few 6-7 story structures. The street of Phyaphal also has modern buildings with ACP panels on the façade. Buildings are directly attached to the streets, except for the stairs, due to the lack of a pedestrian walkway.

7.2.3 Interesting elements and temples at every node

Nodes are key intersections that are defined by the level of activity in that region. They are, in essence, focal places that draw public activity due to their position or the presence of notable components. The streets of Phyaphal, Kilagal, Bhedasing, Indrachowk, and Makkhan are the urban heart of Kathmandu and one of the most compact historic settlements of the Malla town, with temples and open platforms at every node. There is a prominent Akash Bhairab temple at the intersection of Phyaphal and Kilagal, and Makkhan and Phyaphal streets lead straight to the Basantapur Durbar Square. Temples may be found not just at every node, but also throughout the Phyaphal road length and at Kilagal. All of the temples are architecturally significant and exhibit traditional Malla architecture. Because of the temples' presence, each node undergoes a significant transformation. Because these temples in the streetscape interrupt the continuity of the residential structures, there is no monotony along the streets. Most tourists stroll on these streets because of the fascinating cityscape and dramatic changes at every node and along the roadway itself.

7.2.4 Existence of traditional and neo-classical buildings

Traditional Newari buildings with towering decorative door and windows still line the streets of the study area. Desemadu Jhya, an extremely creative window,

is also located on the Phyaphal street. In addition, traditional and artistic Dyochhen may be seen in these streets. These streets have a considerable amount of neoclassical structures. The majority of the structures are still in use as homes. These classic Newari houses with high artistic window carvings, which symbolize our country's rich architecture, are also the main attractions of these streets, attracting a large number of visitors to pass through them. However, in the case of these ancient structures, there is a noticeable lack of adequate care and preservation.

7.2.5 Most vibrant and lively place

The vibrancy of the environment is one of the most important aspects of urban architecture. Owing to the strong flow of pedestrians and cars, the streets are constantly bustling due to their closeness to the historic commercial and market hub Ason and one of the heritage monuments, Kathmandu Durbar Square. Aside from this, the vegetable markets at Kilagal and Bhedasing, the blanket and textile market at Indrachowk, and the high commercial district of Makkhan all attract a large number of pedestrians and tourists, not only from the immediate vicinity but also from all across Kathmandu Valley. The usage of the bottom floor as stores in all of these streets, coupled with street sellers going about their business, gave additional liveliness to the area and made it more fascinating to wander through.

8. Discussion

8.1 Relationship of pedestrian flow and built environment

Most of the buildings in the urban core of Kathmandu are still 4-5 storeys which surround the narrow streets gives a sense of enclosure that provide shade to the pedestrians from the sun while the temples and traditional rest houses provide shelter from the rain. The near proximity of the building and the constant flow of people gives pedestrians a sense of safety and

Table 2: Condition of existing buildings at urban core

SN	Street	Building Storey	Building Facade	Ground Floor Use	Building Type	Distance of street from building
1	Makkhan	4-8 storey	Brick exposed, cement plaster	Shops	Residential and commercial	Attached
2	Indrachowk	4-8 storey	Brick exposed, cement plaster	Shops	Residential and commercial	Attached
3	Bhedasing	5-8 storey	Brick exposed, cement plaster, neoclassical	Shops	Residential and commercial	Attached
4	Kilagal	1-8 storey	Brick exposed, cement plaster, neoclassical	Shops	Residential	Attached
5	Phyaphal	2-8 storey	Brick exposed, cement plaster, neoclassical	Shops	Residential	Attached

security.

8.2 Relationship of pedestrian flow and land use/urban form

As land use changes, so does the dispersion of pedestrians. Pedestrian traffic is higher in mixed-use districts with a variety of activities than in solely residential, institutional, or other sectors. Pedestrian traffic in a mixed-use area is nearly steady throughout the day, with minimal variation. Other land uses, on the other hand, have larger pedestrian volumes during certain hours and have very few pedestrians at other times. Pedestrian distribution is strong throughout the day on streets in the urban centre. Due to footpath commerce by street vendors, the volume swells during peak hours and peaks in the evening. The shops on the ground floor attract a large number of people during the day. As there is increase in pedestrian flow along the streets of the study area, most of the building use have changed from residential to commercial usage where shops in the ground floor are pedestrian targeted as well as the height of the building are increasing. During day time, there is heavy pedestrian flow along the Sukrapath street on both sides of footpath which impact on the building usage of this street where all the buildings are commercial even the street vendors are encroaching the street. It is observed during evening time there is heavy pedestrian flow along the Indrachowk-Basantapur street as people are returning their destination home from shopping or work where people prefer this short cut diagonal street.

8.3 Relationship of pedestrian flow and footpath business

As the pedestrian flow and footpath business are directly proportional to each other, street vendors are drawn to regions with a large volume of pedestrian traffic. Increased footpath commercial activities attract more pedestrians, who in turn bring in more street vendors, perpetuating the vicious cycle. The vegetable markets for the surrounding neighborhood are located on the streets of Kilagal and Bhedasing. A large number of street vendors operate on both sides of these streets, selling their wares on the sidewalks. Street vending is the main character of the streets in Indrachowk, which is a traditional blanket and fabric market, and Makkhan, which is a highly commercial neighborhood, and has been the main draw for a significant number of pedestrians along these streets for shopping purposes. Street vendors are attracted to these streets to run their business because large no. of people walks through these streets to get to the Durbar Square of Traditional market center Ason. As great number of people travel through these streets to go to the Durbar Square of Ason’s traditional market area, street vendors are drawn to run their businesses there.

8.4 Problems and Issues

8.4.1 Narrow streets and no side walks

Of the past, the streets in Kathmandu’s urban core were designed with pedestrians in mind. As a result, these streets are narrow and lack sidewalks. During peak hour, a huge number of pedestrians and automobiles walk together. The main reasons for pedestrians being

hit by vehicles in those neighborhoods are the small streets with no side walkways for pedestrians.

8.4.2 Unmanaged Street Business and encroachment

The pedestrian-only streets in Kathmandu's central core are progressively being encroached upon by street vendors and businesses. After Ason, the streets of Kilagal and Bhedasing are home to one of the most important vegetable markets. Hundreds of vendors occupy the street space for selling vegetables in the mornings from 6-9 a.m. and in the evenings after 6 p.m., and a big number of people from the surrounding neighborhood come here to buy veggies. There is relatively limited space for pedestrians to walk during this period. The two-wheelers, as well as four-wheelers and carts, obstruct pedestrian movement, exacerbating the problem.

8.4.3 Heavy Flow of Vehicles

Due to the active vegetable market at Kilagal and Bhedasingh, the streets of Phyphal, Kilagal, Bhedasingh, Indrachowk, and Makkhan are always bustling with pedestrians and vehicles. There is a constant flow of tripper and loader in the early morning and late afternoon. There is constantly a flow of private automobiles, school buses, micro buses, and a large flow of motorcycles during peak hours. The constant flow of vehicles, along with narrow streets further encroached upon by merchants, creates numerous hazards for pedestrians. There is always the risk of people being struck by automobiles, and there is a severe traffic bottleneck of pedestrians and vehicles at peak hours.

8.4.4 Weak traffic management system

All day long, there is a heavy flow of automobiles and people through the city's narrow streets. Despite the fact that these streets have a one-way traffic control system, vehicles enter from all directions due to inadequate implementation and a lack of severe laws. As vehicles from all directions converge on the narrow streets, traffic congestion worsens, and during peak hour, traffic jams of more than half an hour can be visible. Pedestrians must wait on the side of the road for automobiles to pass. As a result of the poor deployment of traffic control systems, the pedestrian environment has become much worse.

8.4.5 Unmanaged bike parking

People park their bikes along the side of the street because there isn't enough space for organized parking. Bhedsing Chowk's modest open space and Phyphal's corner space are also used for bike parking in the morning and evening. Bike parking is available in Makkhan in the front of the commercial building Suraj arcade. The chaotic bike parking along the street, as well as heavy encroachment by vendors and retailers, leaves very little space for pedestrians, making the already narrow street even narrower.

9. Conclusion

The eleven hourly pedestrian volume measurements revealed that the highest pedestrian throughout is at station 2 along Sukhrapath and the lowest one is at station 7 along Phyphal street with 19.61% and 6.7% of total volume respectively. The pedestrian trip generation is related to land use type and trip purpose. The larger shopping and work trips are attracted to the commercial and institutional areas where as the leisure trips are attracted to the recreational area of Durbar Square. In this study area, the shopping and work trips are predominant. Footpath encroachment, physical condition of walkways, safety issues from the vehicular traffic and crowded footpath are highly prioritized problems in the study area.

10. Recommendation

10.1 Efficient traffic management system

Due to the large flow of vehicles in the narrow streets meant for pedestrians in the past, modern pedestrian movement is problematic. However, because vehicle entry restrictions in urban core streets are unavoidable because they have long been a part of life for urban city dwellers and a means of transporting goods and services, the pedestrian environment can be improved by implementing a proper and efficient traffic management system. Traffic management can be accomplished in a variety of methods, including the following:-

10.1.1 One way traffic system

The street traffic system is largely unmanaged. The main source of traffic bottlenecks is the entry and exit of vehicles from all directions of streets. The street is too narrow to allow two vehicles and pedestrians to

pass at the same time. As a result, a one-way traffic system could be one of the finest alternatives for improving pedestrian flow in urban center streets.

10.1.2 Entry of heavy vehicles at certain hours of day

The entry of heavy vehicles should be limited throughout the day in order to promote pedestrian circulation. Vehicles should not be permitted until 7 to 9 a.m. in the morning, or after 7 p.m. in the evening. This would help to decrease the traffic jam and enable free peak time mobility.

10.2 Management of footpath business

The location of potential vending pockets will be factored into pedestrian space planning. Vendors on both sides of a footpath must be discouraged; however, space between physically obstructing objects such as tree guards and rest/sitting benches can be allowed for street vending; and the vendor factor must be included in the design of the effective width of the footpath in the transportation hub.

10.3 Establishing "Zones of Footpath"

Where enough space for pedestrians is available, the pedestrian area should be clearly separated into four zones: edge, furnishing, throughway, and frontage. Following that, these zones should be appropriately planned with the required features to allow for effective pedestrian circulation.

10.4 Building Controls

The visual disturbance of the urban cityscape is caused by the non-uniformity of building heights. Uneven construction plinth heights, private building stairs encroaching on public pathways, and house owners projecting cantilever over footpaths are just a few examples of how stringent enforcement of bye regulations is making the pedestrian environment more challenging. As a result, the concerned institution should be strengthened to severely enforce the building byelaws in order to regulate construction uniformity and private building encroachment on public sidewalks.

10.5 Appropriate Parking Policy

The parking policy in Kathmandu primarily consists of the following two categories, which may be found

in the streetscape of each city road.

10.5.1 On street Parking Policy

On-street parking should be forbidden in all central area streets, with the exception of designated zones, as a general policy. Charges should be levied at an hourly rate that steadily increases over time in all of these areas. The price of parking can thus be used to regulate the number of people who drive personal vehicles.

10.5.2 Off Street Parking Policy

For greater pedestrian amenities on the streetscape, the off-street parking policy should be improved. To create areas for off-street vehicular parking, severe development regulations should be enacted. Pedestrians should be included into the land use by off-street parking, decreasing traffic congestion on the street.

References

- [1] Naresh Giri. Integration of pedestrian planning into urban transportation system: A case study of tudhikel area of kathmandu valley, 2010.
- [2] MoPIT/JICA. Final report: Data collection survey on traffic improvement in kathmandu valley, 2012.
- [3] ManavKendrit Yatayat Abhiyan. Walkability in kathmandu valley, 2013.
- [4] B.K.Shrestha. Street typology in kathmandu and street transformation. 2011.
- [5] John J. Fruin. *Pedestrian Planning and Design*. 1st edition, 1973.
- [6] Federal Highway Administration. *A pedestrian Planning Procedures Manual*. Washington DC, USA, 1978.
- [7] John J. Fruin. *Designing for pedestrians: a level of service concept*. Highway Research Record, 1971.
- [8] P.S. Kanargoglou W.P. Anderson and E. Miller. Urban form, energy and the environment: A review of issues, evidence and policy. 1996.
- [9] A. Churchman. Disentangling the concept of density. 1999.
- [10] E. Talen. Neighbourhoods as service providers: a methodology for evaluating pedestrian access. 2003.
- [11] Ramita Tachamo. Planning for pedestrian in urban area: A case of kathmandu, 2013.