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Planning for Pedestrian Oriented city, a case of Amritsar

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Abstract
With the population increasing rapidly, there is increase in the traffic congestion on the Indian roads. Environmental pollution and congestion caused by the automobiles had worsened the scenario for pedestrians in the Amritsar city. The pedestrian infrastructure and amenities in the city is in the state of neglect. So, the major idea is to improve the environment and infrastructure in the city and creating an attractive and a safe pedestrian environment would be a key to develop more livable and walkable communities. Also, there is an immediate need to manage and sustain the transport system in the city and to correct the current scenario of traffic congestion, road accidents and neglected pedestrian infrastructure. So, in the current scenario, this paper aims to study the condition of the pedestrian environment and make strategies to improve the same and make a pedestrian-oriented city creating healthy future for the community by making the walkable spaces more attractive and convenient. The objective is at improving and integrating the pedestrian environment by thoroughly studying the components and concept of pedestrianization and their role in urban living and planning. The emphasis has been laid upon the aspects such as Studying the best practices, planning and design standards, innovative strategies and drawing useful guidelines for the city, Analyzing the problems of pedestrian environment in few select areas of city in the context of urban planning and development, Improving the pedestrian environment of the areas of the city.

Keywords: pedestrian, characteristics, components, behavior, analysis

1. Introduction
Every year about 1.25 million people die as a result of road traffic injuries. Half of those dying on the world's roads are "vulnerable road users" like pedestrians, cyclists and motorcyclists. Without action, road traffic crashes are predicted to rise to become the 7th leading cause of death by 2030. - Road traffic injuries, World Health Organization. Each year, more than 2, 70,000 pedestrians lose their lives on the world's roads. Globally, pedestrians constitute 22% of all road deaths. The risks to pedestrians include issues related to multiple factors like driver behavior, particularly in relation to speeding as well as drinking and driving, pedestrian road crossing behavior, infrastructure in terms of a lack of dedicated facilities for pedestrians such as sidewalks, and vehicle design and poor trauma care services. (WHO). There is a need to provide successful interventions to protect pedestrians and promote safe walking require an understanding of the nature of risk factors for pedestrian crashes. Hence, this study paper is an effort to make an attempt to study the pedestrian risks and their crossing behaviors, which helps policy makers to make decisions on pedestrian safety.

2. About the city Amritsar
Amritsar, the second metropolitan city of Punjab consists of municipal corporation, has a total population of 1,132,383 is spread across an area of 142.37 sq.km (including Amritsar Cantonment) according to 2011 Census. The climate is generally considered as dry weather except the brief southwest monsoon season, hot summer and brisk winter. Temperature varies from -3 to 47.7 degree Celsius, so study has been done keeping in mind the climatic conditions. With the population increasing rapidly, there is an increase in the traffic congestion on the Indian roads. Environmental pollution and congestion caused by the automobiles had worsened the scenario for pedestrians in the Amritsar city. The pedestrian infrastructure and amenities in the city is in the state of neglect. There is an immediate need to manage and sustain the transport system in the city and to correct the current scenario of traffic congestion, road accidents and neglected pedestrian infrastructure. The major idea is to improve the environment and infrastructure in the city and creating an attractive and a safe pedestrian environment would be a key to develop more livable and walkable communities. So, this paper describes various components of the pedestrian environment.

3. Methodology and Literature Review
3.1 Defining Pedestrians
Pedestrians include any person walking, running, standing or sitting on a road or persons in a toy vehicle, a pram or in a mobility device not capable of exceeding 10 Km/h. (Sachin Dass, 2015) [12]. p.38 or A pedestrian is a person who walks, sits, stands in public spaces, or use a mobility aid such as walking stick, crutches or wheelchair, be they children, teenagers, adults, elderly persons, person with disabilities, workers, residents, shoppers A pedestrian oriented design is accessible design by all the people (IRC, 2012) [5]. Pedestrians can be classified on the basis of their capabilities to use pedestrian facilities as children, elderly people, disabled people and others. Children tend to be impulsive in making crossing decisions. Young children, due to their low height are likely to be less noticed by speeding motorists as compared to adults. Elderly people are generally slow to react, walk at a slower pace compared to other groups; visual acuity can be compromised and may have decreased stability to walk. Some elders may also use assistance for walking. (Such as handholding, walk stick,

etc.) Disabled people can be people with different restricted abilities such as visually impaired, walking disabilities (people on wheel chairs or crutches), etc. The rest comprise of average adults whose ability to walk safely is not compromised. Such people have an average walking speed of 4 ft. /sec (or 1.22 m/s or 4 km/hr.) (UDD, Guidelines for Planning & Implementation of Pedestrian Infrastructure, 2014) [14].

3.2 Pedestrian Characteristics

The decision to walk usually takes into account the distance of the trip, the perceived safety of the route, and the comfort and convenience of walking versus an alternative mode. Following are the factors that define a pedestrian characteristics':

3.1.1 Walking speed

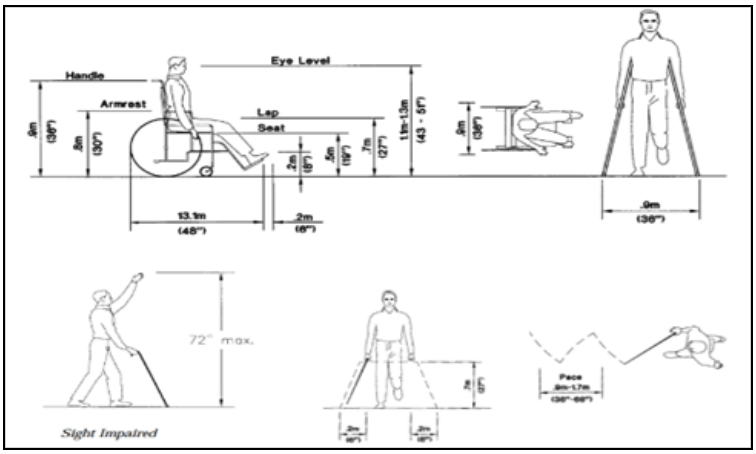
Walking speed of pedestrians may vary by age and physical ability. Pedestrian's typical walking speed is 1.4 m/s (5 km/h). Also, a mean start-up time (from the start of the walk signal to the moment the pedestrian steps off the curb and start to cross) is assumed to be 2.5 s for older pedestrians, compared with 1.9 s for younger ones (Otak, 2002) [11].

3.2.2 Acceptable Walking Distances

An average person finds it comfortable to walk a distance of 1.5 km (US report).

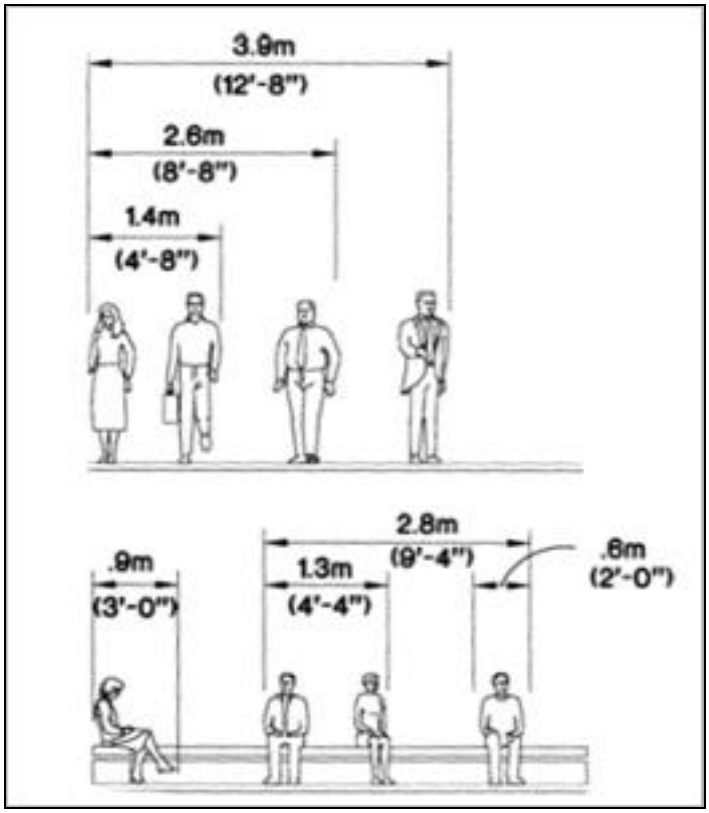
3.2.3 Pedestrian space requirement

A body buffer zone of 0.75 sq. m is recommended. For two people walking side-by-side or passing each other while travelling in opposite directions, the average space taken up is 1.4 meters (4 feet 8 inches) (Otak, 2002) [11] (Refer figure 1). Space requirements for pedestrians with disabilities vary considerably depending upon their physical abilities and the assistive devices they use (Refer figure 2).



Source: Accessible Design for All

Fig 1: 1 Disabled space



Source: Time-Saver Standards for Landscape architecture

Fig 2: Pedestrian space requirement

3.3 Understanding Pedestrian Level of Service

Pedestrian level of service indicates the environmental qualities of a pedestrian space and serves as a guide for development of standards for pedestrian facilities. Pedestrian delay in crossing the road is also used as basic criteria in defining the Level of Service at pedestrian crossings (Refer table1).

Table 1: Pedestrian Level of Service at Road Crossing

Level of Service	Waiting Time in seconds
A	≤3
B	> 3 and 13 ≤
C	>13 and 38 ≤
D	>38 and 64 ≤
E	>64 and 90 ≤
F	>90

Source: IRC 2012

3.4 Components and Design Standards

Various components of pedestrian friendly environment should possess the following requirement.

3.4.1 Footpaths

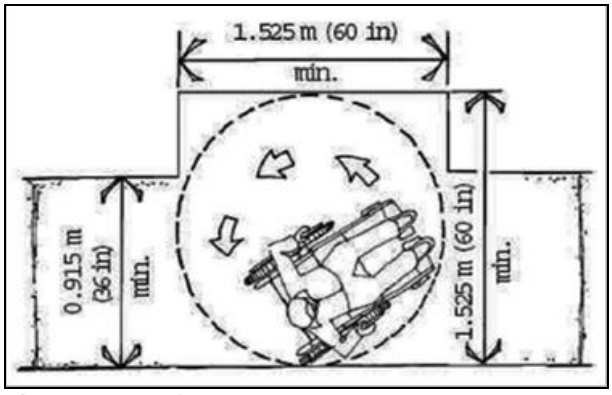
Footpaths or sidewalk is the portion of the street reserved only for pedestrians. It is to be provided on both edges of the street. Sidewalks can be on one side of a street only under special circumstances where people do not need to access the other side of the street. For example, on a street running adjacent to a railway line with establishments/residences only on the side opposite to railway line, with on-street parking restrictions adjacent to railway line and restricted right-of-way, footpath/sidewalk may be provided on one side only. Capacity and width of footpaths depends on the hierarchy of road (Refer table 2). Attributes of good footpath design includes the following:

Table 2: Capacity of Footpaths

Type of Road	Design Speed (Kilometer per hour KPH)	Space Standards (m)	Width of sidewalk (m)	Capacity of Footpaths per hour in both directions
Expressways (6 lane divided)	80	60	4	3600
Arterial road (4 lane divided with separate cycle lane)	50	50-60	3.5	3150
Sub Arterial Road	50	30-50	3	2700
Distributor/Collector Roads	30	Dec-30	2.5	2250
Local Street	10-20	Dec-20	2	1800
Access Street	15	Jun-15	1.8	1350

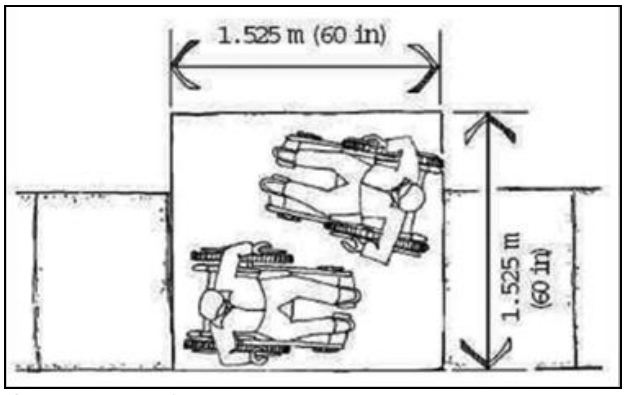
Source: IRC (103-2012)

Footpaths should be Connected and continuous provided on both sides of road above the level of carriageway separated by curbs, curb height should not exceed 150 mm, should have Clear Walking Zone 1800 mm wide, which is the width required for two-wheel chairs to comfortably cross each other (Refer figure 4), preferably 2000 mm and clear of vertical obstructions with 2200 min clear height. In order to achieve minimum clear width of unobstructed walking zone, all such elements like trees, street lights and street furniture should be accommodated within in MUZ (multi utility zone) wherever provided. (Refer figure 3), should be obstruction free, in case of obstructions that cannot be removed Warning marking should extend over a width of 600 mm outside the projected area on raised platform of 100 mm, Fixed pole should have contrasting colored marking strips of 300 mm length at a height of 1400 mm to 1600 mm, Width as per adjacent land use (Refer Table 3), Guard rails to be provided at junctions, near schools, bus stops/railway station, overpass/subways. Height of the guardrails should be sufficient in order to deter people from climbing over it i.e. 1100 mm. Visibility should not be obstructed and setback from the carriageway by at least 150 mm.



Source: UDD, 2014

Fig 3: Wheel chair specification



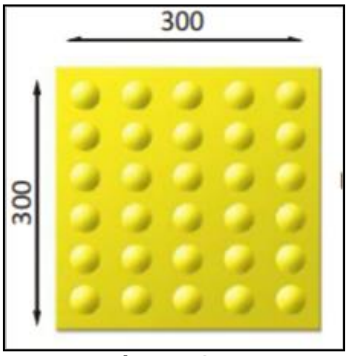
Source: UDD, 2014

Fig 4: Clear width for disabled

Table 3: Required width of footpath as per adjacent land use

Description	Width of sidewalk (m)
High Intensity Commercial Areas	4
Shopping Frontages	3.5 to 4.5
Bus Stops	3
Commercial/Mixed Use Areas	2.5
Residential/Mixed Use Areas	1.8

Source: IRC (103-2012)

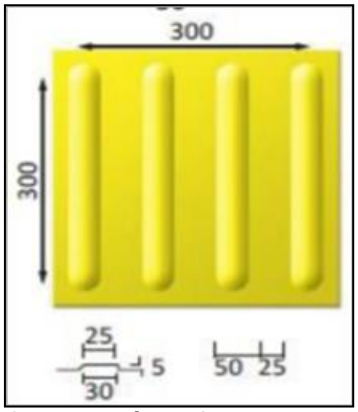


Source: Urban Street Design Guidelines, 2014

Fig 5: Warning Block Specifications

3.4.2 Tactile Pavers

Usually persons with vision impairment need guidance in using a pedestrianized area. The different texture can be followed by people using a long or white cane, and also be detected underfoot by others with low vision (IRC, Guidelines for Pedestrian Facilities, 2012) [5]. Guide blocks has straight continuous line and indicate the correct path leading to buildings entrances, bus stop etc. They should be provided in different texture to the rest of footpath can provide guidance and not to be located close to manhole or drains. (Refer figure 6) Warning Blocks provides warning signal to screen off obstacles or other hazards, to discourage movement in an incorrect direction and to give warning of a junction. They should be placed 300 mm at the beginning and end of the ramps, stairs and any entrance and should be laid 600 mm wide across the entire footpath where the crossing occurs. (Refer figure 5)



***Source*:** Urban Street Design Guidelines, 2014

Fig 6: Guide Block Specifications

3.4.3 Pedestrian Crossings

Key guidelines for Pedestrian crossing are as 3000 mm minimum width of pedestrian crossing and 2500 wide minimum cycle crossing should be provided at all road crossings. All crossings should have universal accessibility features and street directional signage.

At-grade crossings

With respect to locational aspects, such crossings could be classified as Pedestrian crossings at intersections (signalized crossings) and At-grade pedestrian crossing away from intersection (eg. mid-block crossings). Components of at grade pedestrian crossing are as follows

1. Zebra crossing: It is a clearly specified pedestrian track across the carriageway and is delineated with the help of alternate black and white stripes, which should have embossed texture for easy detection by persons with vision impairment. A zebra crossing should always be accompanied by a “STOP” line. Width of crossing should generally lie within a range of 2-4 m. (Refer figure 2.6)
2. Guard Rails: Guard Rails in the vicinity of zebra-crossing should be of sufficient length to deter pedestrian from crossing the road. Night time visibility of zebra crossing is of vital importance and can be achieved through proper lighting of the intersection area
3. Pedestrian refuges: Pedestrian refuges with at least 2m width are an effective way to help disabled and elderly pedestrian and do reduce pedestrian accidents
4. Signalized Crossings: The red phase should keep traffic stopped for minimum 12 seconds for a 7.5 m crossing. Pelican Signals are useful particularly at mid-block crossings, color contrasted with raised alphabets push buttons diameter of 50 mm raised button by a closed fist can be activated. Audible signals can be useful for visually impairment, among children
5. Mid-block zebra crossings: They are to be provided when the distance between two consecutive intersections is more than 300 m and simultaneously. Refuge Islands are must at mid-block crossings. Raised crossing or table top crossing are recommended and should match with the level of the footpath. Signages should be visible from minimum 100m away and Minimum 20-second pedestrian signal should be provided (IRC, 2012) [4].

Grade separated crossings

Provision of a grade separated pedestrian facility may be warranted at locations where one or more of the following conditions exist: Volumes of pedestrian and vehicular traffic are so large that insertion of an exclusive pedestrian phase will increase the cycle time for traffic signals beyond 120 seconds or Control at-grade pedestrian crossing decisively fails to mitigate the problems of pedestrian-vehicle collision.

Foot over bridge (FOB) - Pedestrian crossing is on a bridge at specified height over the street level. All foot over bridges with a minimum width of 2.50m and subways with minimum width of 4.80m should be universally accessible. (Staircase + Ramp or Staircase + Elevator for universal accessibility). Minimum size of the elevators provided for foot over bridge or subways should not be less than 1.4m x 1.4m. For ramps, a 5% slope with appropriate landings is preferable. Grade separated crosswalks should be well lit and pleasantly decorated to create an inviting atmosphere for pedestrians to use. The foot over bridge should be provided with roof covering and the sides of the FOB should not be fully covered as it hampers visibility (UDD, Guidelines for Planning & Implementation of Pedestrian Infrastructure, 2014) [14].

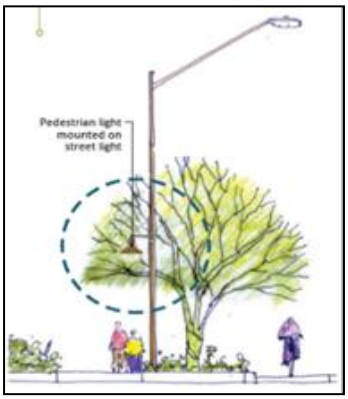
3.4.4 Ramps and Steps

Ideally both steps and ramps should be provided. Some persons with disabilities (such as crutch users) find it easier to use steps rather than a ramp. However, in the external environment, if there is no room for both, a ramp should be

provided. The route should not be torturous nor deliver persons out of the way in which they want to go (IRC, 2012) [4]. A ramp should be accompanied by a flight of easy-going steps. Slope of ramp is to be a maximum of 1:12. Tactile warning should be provided before the end to indicate change in gradient. Uniform risers of 150 mm and tread of 300 mm shall be adopted for the stairs. Stair edges should have bright contrasting colours. Maximum height of a flight between landings shall be 1200mm. landing should be 1200 mm deep, clear of door swing. The steps should have unobstructed width of 1200 mm. Handrail should extend 300 mm beyond the ramp and steps at the top and bottom in contrasting colors are essential and should be circular in diameter of 38-40 mm (IRC, 2012) [4].

3.4.5 Kerbs

A Kerb or curb is the edge where a raised sidewalk or road median/central reservation meets a street or other roadway. Curbs may fulfil any or several of a number of functions. By defining the edge of the pavement, they separate the road from the roadside and discourage drivers from driving on sidewalks. They also provide structural support to the pavement edge. Curbs can be used to channel runoff water from rain or melted snow and ice into storm drains (IRC, 2012) [4]. Height of pavement including kerb, walking surface, top of-paving shall not exceed 150 mm. Medians should be maximum of 250 mm high. Only along the busways/BRT corridor, kerb height could match the height of bus floor. For movement of largest size of vehicles, maximum corner radius should be 12 m. In residential areas, kerb radius may be reduced to 6 m. Standard kerb ramps are cut back into the footpaths at a gradient not more than 1:12. Width of ramp should be at least 1200 mm with flared sides providing transition in three directions It is desirable to provide two kerb cuts per corner. Single ramp in the corner is not desirable.



***Source*:** Hawaii County Pedestrian Safety Action Plan Template

Fig 7: Pedestrian Light Fixture

3.4.6 Lighting

Personal security is especially important to vulnerable groups such as elderly people and women (including girls and women with disabilities) more than men and good lighting is particularly necessary for pedestrian crossings. Must be provided at every 20-30 m of interval not exceeding a height of 4m from ground grade level. White lighting at 25-40 lux for footpaths is recommended Higher lighting levels (80 lux) using special light poles for pedestrian crossing is recommended while lower level light poles are preferred to avoid shadow where there are high trees (Refer figure 7) (UTTIPEC, 2009) [17].

3.4.7 Street Furniture

Street furniture's purpose is to cater to the comfort need of the road users especially pedestrian and cyclist. Provision of resting places - simple sitting areas with chairs, benches or steps where one can have a break - is an important element of pedestrian spaces. Along frequently used pedestrian ways, seating should be provided at regular intervals, typically every 50 meters. Seats can be as simple as wooden benches or perch-type painted in contrasting colors (DDA, 2009).

3.4.8 Bollards

Bollards are often used to stop vehicles from entering the footpath and to keep pedestrian away from vehicular traffic. (Refer figure2.8) They should be provided at all the refuge areas for the safety of pedestrians. They should be 1200 mm wide and 1000 high (IRC, 2012) [4].

3.4.9 Road Markings

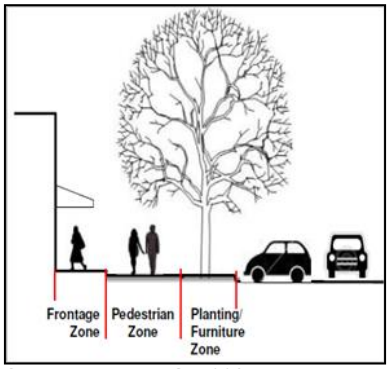
Road markings is an essential element which is required for improving efficiency of the street. There are two types of road markings: Non-Mechanical Markings – Paint Markings, Plastic and Epoxy Markings and Mechanical Markings – Cats Eye, Reflective posts. These are done in four basic colors: White – used for permissible, informative, yellow – used for preventive, cautionary, Blue – Special purpose marking and Green – Non-Motorized Transport markings. Listed below are the markings to be used for pedestrians (IRC, 2012) [4]. Marking for pedestrian crossing mostly used is zebra pattern consisting of equally spaced white stripes generally 500 mm wide. At intersections, a stop line at a distance of 2 to 3 m for unsignalized intersections and at a distance of 1 m from signalized intersections. All objects located within 1.5 m beyond the formation width of the road shall be painted. Poles close to the carriageway shall be marked with alternate black and white horizontal stripes up to a height of 1.25 m above the road level and shall be uniform and each not less than 100 mm wide. In case of trees, marking shall be up to a height of 1.25 m above the road level with a 300 mm bend in black paint in the middle of this height for enhanced visibility. Guard rails, guard stones or drums and trees that are not likely to be hit unless a vehicle runs off the carriageway, shall be painted solid white. Kerb markings should be equally spaced black and white strips generally 500 mm wide or a checkered black and white design.

3.4.10 Signages

The total length of signal cycle should be 120 sec or less, that being the maximum acceptable delay for drivers and pedestrians. Pedestrian signals should be installed at all pedestrian crossings at a signal-controlled intersection. It should be ensured that pedestrian signals are properly aligned with the zebra crossings. Timings of pedestrian signals should be given as Time in seconds = 7 + length of the crossing stretch in metes (For example - if the single crossing stretch is 10m in length, pedestrian phase time duration should be 7+ 10 = 17 seconds). Mid-block crossings should be controlled by signals at places with high pedestrian volumes. Pelican signals should be installed in such areas. The primary shall be at the near side of the

intersection at the stop line on the left side of the approaching traffic. The secondary shall be on the far right of the intersection, or at the median island if available (UTTIPEC, 2009) [17].

3.4.11 Landscaping



***Source*:** UTTIPEC. 2009

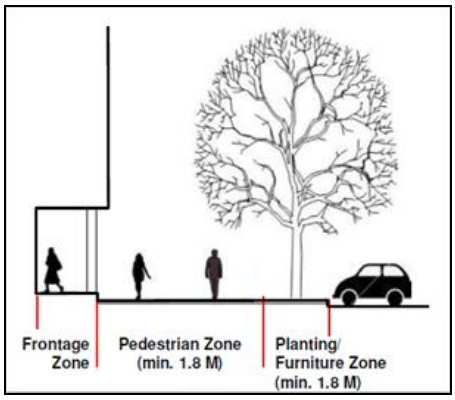
Fig 8: Division of zones in Residential Area

Street trees should typically be upright and branched above 2.4m to provide adequate walking clearance under branches. Plantation at edge of footpath (even within private premises) should not be of a type which would overgrow and spread on to the footpath blocking pedestrian path. Under no circumstances should trees be placed within the 1.8 M clear horizontal Walking zone. (Refer Figure 8, 9). Large and spreading shade trees, with thick foliage are proposed to provide much needed shade on hot roads during summer as desired by the climatic conditions of the city. Spacing of trees should be 3 m (IRC, 2012) [4].

3.4.12 Pedestrian facilities at Transit Areas

The distance should be shortest and the most direct route should be safe. So, from this perspective, there should be pedestrian friendly environment with minimal conflict and pedestrian needs should be taken care of for different types of transit areas. Pedestrian should not have to walk more than 200 m to ramp or elevators to change floor level to access transit 1.8-2 m for light pedestrian traffic and 5 m for heavy traffic. Crosswalks should be provided at 30 m on the pedestrian streets. Zebra crossings should be in range of 2-4 m. Use of special paving to link pedestrian path to transit areas should be there (UTTIPEC, 2009) [17].

3.4.13 Multi-Functional Zones



Source: UTTIPEC. 2009

Fig 9: Division of zones in Commercial Area

Zones on a Street should be a minimum of 1.8 M Wide, and may locate any or all of the following functions within them: Tree Planting; Planting for Storm Water Management; Auto-rickshaw Stands; Cycle rickshaw Stands; Hawker Zones; Car Parking; Street Furniture; Bus Stops, Street lights/ pedestrian lights. Provision of MFZ is most critical otherwise the above uses/ components of streets would encroach upon pedestrian, cyclist or carriageway space. Common Utility Ducts should not be located under the MFZ as there may be intrusion due to trees. Hawker Zones must pe provided within the Multi-functional Zone (IRC, 2012) [4].

3.4.14 Public Toilets

Public Toilets, including one for persons with disabilities - must be located every 5 km. The compartment should be at least 2200 mm and 2000 mm and should have clear spacing of 1500 mm*1500mm in front of WC.

3.4.15 Universal Accessibility

Universal Accessibility is required for all sidewalks, crossings, parks, public spaces and amenities – for people using wheelchairs, strollers, walkers, crutches, handcarts, bicycles, aged people, visually or hearing impaired, and pedestrians with temporary mobility impairment or injury (IRC, 2012) [4]. Standard kerb ramps are cut back into the footpath (flush with roadway), at a gradient no greater than 1:12, with flared sides (1:10) providing transition in three directions. Width of the kerb ramp should not be less han 1.2 M. Tactile warning strip to be provided on the kerb side edge of the slope, so that persons with vision impairment do not accidentally walk onto the road. Mid-block crossings accessible for persons with disability should be provided for blocks longer than 250M. Raised crossings should be located at: At Slip Roads (free left turns), Where high-volume streets intersect with low-volume streets, such as at alley entrances, neighborhood residential streets, and service lanes of multi-way boulevards. Audible crossing signals (pelican crossings) help everyone, as well as being essential for persons with vision impairments. A slope of 8% (1 in 12) on footbridge ramps, while a slope of 5% (1 in 20) with suitable resting places should be provided. Within the underpass, a handrail set 850mm-900mm above the walking surface should be provided. Elevator/lift should be provided on both the entrances/exits and should have minimum internal dimensions of 1400mm x 1400mm. All Lifts to have Braille buttons and audio announcement systems. The minimum width of Tactile Paving should be 300mm so that someone cannot miss it by stepping over it.

3.5 Parameters undertaken

To evaluate the actual condition of the pedestrian environment of the city, there are various parameters derived from the above study on the basis of which the stretches are being evaluated to further provide necessary measures to be intervention. So, below are the parameters listed?

3.5.1 Universal Accessibility

All pedestrian facilities and amenities within the pedestrian facility should be universally accessible to people of all abilities such as people on wheel chair, visually impaired, etc. So, stretches are being analyzed on the basis of the

height and width of footpath, levels of the pedestrian crossings as that of footpath, provision of ramps in footpath, signalized crossings, tactile paving for the disabled, level and width median refuge area, ramp gradient, opening in the railing for accessing footpath.

3.5.2 Connectivity
Pedestrian facilities should be well networked for pedestrians to choose the most convenient path without getting in conflict with vehicular traffic. Stretches are being analyzed on the basis of the design of the start and end levels accessing the footpath, location of pedestrian crossings, alignment of footpath, clear sidewalks with no obstruction such as trees or pole, location of pedestrian subways and Foot over bridges.

3.5.3 Safety and Security
Pedestrian facilities should provide a sense of safety to the pedestrians and they should not be threatened by vehicles. Pedestrian facilities should be perceived to be safe for use by pedestrians of all types including disabled, women, children and elderly people. Stretches are being analyzed on the basis of the provision of traffic calming measures, pedestrian markings such as stop line marking, zebra crossing marking, accessibility of footpaths exclusively for pedestrians, provision of handrails, lightings of footpath as well as crossings, placement of bollards, pedestrian signals, hawking spaces, table top crossings, continuity of footpaths, provision of ramps, covered drainage holes.

3.5.4 Ambience
Pedestrian facilities should have good ambience to make the facilities seem inviting for pedestrians to use. Pedestrians are human, who feel, and have emotions unlike vehicles. Feelings and emotions of pedestrians are affected by their surroundings; ambience of the space around them and they respond accordingly to make decisions whether to use a facility or not. So, ambience, comfort and safety of their surroundings should be given due consideration while planning for the pedestrian facilities and so stretches are being analyzed on the same basis.

3.5.5 Comfort and Convenience
Pedestrian facilities should be comfortable to use for people of all ages and abilities. Pedestrians use their own power to move and are more exposed to any adverse environmental conditions compared to motorists. As such pedestrian facility should be designed to provide as much comfort as possible to all pedestrians. Comfort will be a value addition to pedestrians and encourage people to walk rather than using other modes of travel. Stretches are being analysed on the basis of the provision of adequate width of footpath, provision of pedestrian utilities such as resting areas, drinking water along the footpath, enough plantation to provide shade, adequate offsets between building line adjacent to footpath.

4. Amritsar City: Pedestrian Possibilities
Amritsar city lies in the main Grand Trunk Road (G.T. Road) from Delhi to Amritsar connecting to Lahore in Pakistan. NH-1 connects the city to Jalandhar and NH-15 links the region with Tran Tarn District towards southern side. These two national highways connect the city to other nearby urban centers. The road network of the Amritsar City is radial-cum-circumferential covering an area of 139 sq.km. The total road length is about 525 km as per the city development plan of Amritsar. (CMP, 2012) Nearly 1388.67 hectares of the area which is 16.66% of the total developed area and 9.75% of the total municipal area of the city is under road network which comprises of roads, railway line, terminals such as bus stand, truck stand, railway station, airport and parking lots/areas existing in the Amritsar city. The city has eleven radials emerging out or leading to the Amritsar city, which are Ram Tirth Road, Ajnala Road, Loharka Road, Fatehgarh-Churian Road, Majitha Road, Batala Road, Sri Hargobindpur Road, G.T Road towards Jalandhar, Tarn Taran Road, Jhabal Road and Attari Road (Master Plan Amritsar). Here in the city, the width of the arterial road ranges from 20 meters to 50 meters and sub-arterial road ranges from 15 meters to 20 meters. Five stretches in total have been selected where the pedestrians are found to be most affected on the basis of the accident profile given by the Amritsar police department. Further, focus has been given to the stretches having mix land use along the roads including residential, commercial, public and semi-public followed by the BRTS routes which helps the people to commute to and from the city's busiest areas. The selected stretches are as Ajnala road, Majitha road, Batala road, GT road, Fatehgarh-Churian road, and Ram tirth road. All these important roads connect the city to other parts of the district. Pedestrian characteristics of each road has been studied and analyzed considering the necessary parameters, pedestrian count survey (Refer table 4) has been carried out, LOS criteria for pedestrians at signalized crossing has been calculated based on which the critical stretches have been figured out.

Table 4: Pedestrian count survey on various roads

Location	Time of survey	Car	Two-Wheeler	Auto Rickshaw	Bus	Cycle Rickshaw	Bicycle	Pedestrian
Ajnala Road	5.30 - 6.30	858	1312	270	21	207	205	165
Batala Road	5.30 - 6.30	557	1096	555	48	186	200	406
Majitha road	5.30 - 6.30	544	1246	516	112	294	364	486
Ftehgarh-Churian road	5.30 - 6.30	1747	2290	1288	132	248	309	343
Ram- Tirth road	5.30 - 6.30	242	480	276	17	100	120	162

Source: Primary Survey

Fig 10: No provision of Zebra crossing marking at

Source: Primary Survey

Fig 11: No provision of ramp in Sidewalks

Source: Field survey and computed values

Fig 12: Sidewalks are encroached by the hawkers

The length of the ajnala road up to MC boundary is 4 kms. The land use along the stretch is mix land use, commercial, residential and public. Due to the commercial and public nature of the area, number of commuters are on foot. The stretch has network of BRTS running. The width of the footpath varies from rialto chowk to hartej hospitral intersection which is 1.5 meters and from hartej hospital to ajnala bypass junction is 2 meters which. The pedestrian share on the stretch has been found to be 6%. No ramp has been provided for the wheel chair users. There is no continuity of footpaths on the stretch as footpaths are been encroached by parking, hawkers, poles, trees. (Refer figure10) Also, LOS criteria for pedestrians waiting time at the signalized intersections has been calculated based on the field survey conducted and it was observed the pedestrians have to wait for around 32 sec to 40 sec leading to delay of 15 to 20 sec which comes out to LOS B and C respectively at the hartej hospital chowk and for around 42 sec to 48 sec leading to delay of 12 to 18 sec which comes out to LOS B at the Kacheri chowk.

The land use along batala road stretch is mix land use, commercial, residential and public. It is observed that the pedestrian share on the stretch has been found to be 14 %. The width of the footpath is measured as 2metre, no ramp has been provided for the wheel chair users (Refer figure11). There is no continuity of footpaths on the stretch as footpaths are been encroached by parking. There is no separate provision of spaces made for hawkers, they encroach the place where ever find suitable space. It was observed the pedestrians have to wait for around 24 sec leading to delay of 4 sec which comes out to LOS A at the celebration mall chowk and for around 22 sec leading to delay of 2 sec which comes out to LOS A which is because pedestrians cross where ever they find place irrespective of the harm which can be caused to them because of such irresponsible behavior.

Source: Primary Survey

Fig 13: Discontinuous Footpath by electric pole installation

The land use along the majitha road stretch is mix land use, commercial, residential and public. The pedestrian share on the stretch has been found to be 12 %. Human violations are done by the motorists at the intersections which is 50% who hardly give way to the pedestrians at the traffic lights to cross and pedestrians themselves are least cared about their lives. The width of the footpath is measured as 2 meters, no ramp has been provided for the wheel chair users. There is no continuity of footpaths on the stretch as footpaths are been encroached by parking, hawkers, poles, trees in between (Refer figure 12). Zebra crossing has been marked but visibility is almost zero. There is no separate provision of spaces made for hawkers, they encroach the place where ever find suitable space. It was observed the pedestrians have to wait for around 28 sec leading to delay of 11 sec which comes out to LOS B at the 4S chowk and for around 32 sec to 35 sec leading to delay of 14 sec to 17 sec which comes out to LOS B because there are no pedestrian signals

installed and installed traffic lights are not working near Sacred Heart School intersection.

***Source*:** Primary Survey

Fig 14: Unauthorized vehicular encroachment

The pedestrian share on the Fatehgarh-Churian road stretch has been found to be 6%. Human violations are mostly done by the motorists at the intersections which is 71% who hardly give way to the pedestrians at the traffic lights to cross. The width of the footpath is measured as 1.5metre, no ramp has been provided for the wheel chair users (Refer figure 13). It was observed the pedestrians have to wait for around 25 sec to 30 sec leading to delay of 10 to 15 sec which comes out to LOS B at the railway chowk. (Refer table 4.9) and for around 18 sec to 21 sec leading to delay of 3 to 6 sec which comes out to LOS A at mall road intersection. are not maintained, obstructed by poles, encroached by hawkers and vehicular parking.

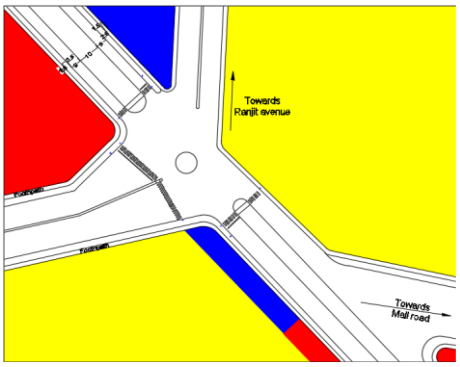
The pedestrian share on the Ram-tirth road stretch has been found to be 12%. Human violations are mostly done by the motorists at the intersections which is 67 % who hardly give way to the pedestrians to cross. There is no provision of footpath on the whole stretch. Zebra crossing has not been marked but, no guard rails has not been provided anywhere on the whole stretch (Refer figure 14) Provision of lights and pedestrian signage along the footpaths has not been made, so people walk in the middle of the carriageway risking their lives. There is no separate provision of spaces made for hawkers, they encroach the place where ever find suitable space. It was observed the pedestrians have to wait for around 32 sec to 40 sec leading to delay of 14 to 20 sec which comes out to LOS C at the cantonment intersection chowk and for around 18 sec to 20 sec leading to delay of 11 to 13 sec which comes out to LOS B at the GT road intersection.

5. Proposals and Recommendations

5.1 Policy recommendation

1. The pedestrian routes must be safe and well-protected from harsh weather.
2. All the city streets must be made pedestrian and bicycle-friendly and universally accessible.
3. The local authorities must ensure a rigorous cleaning and maintenance regime
4. Traffic calming techniques, traffic management and regulation, parking facilities, encouraging informal trade etc. would provide special aid to pedestrianization strategy
5. Special zones must be demarcated for hawking and vending activities/weekly markets.
6. All development plans must involve the design and planning for pedestrian facilities.
7. Pedestrian movement must be integrated with the public transportation system to achieve transit-oriented development.
8. Compact and mixed land-use developments support walking as a major mode of transport.
9. Upcoming developments must be pedestrian-friendly to incorporate major uses within convenient walking distances. Preparation of pedestrian plans must be made mandatory in the design of new townships and developments.
10. Campaigning and advertising could create an impact in sensitizing and creating awareness amongst people towards walking.
11. Congestion tax, parking charges and a part of the motor vehicle tax should be strictly imposed and can be contributed for financing the maintenance of the pedestrian infrastructure.

5.2 Stretch wise proposals



***Source*:** Computed drawing

Fig 15: Pedestrian crossing and stop line parking

For Ajnala Road: Pedestrian crossing marking are to be marked at all the four sides of roads accompanied by stop line at least 1 meter before zebra marking at kacheri chowk. Pedestrian signals and pedestrian signage has to be installed before 5 meters from zebra crossing marking. (Refer figure 15). Mid- block crossings are to be provided at every 250-300 meter as per the standards according to the mixed land use nature along the stretch on the desired locations are proposed, Also, these can be can be painted in 3D for a more visual effect and to make the motorists aware from quite a long distance so that they could speed down their vehicles and stop before the crossings (Refer figure 16). 1000 mm high Bollards, 1200 mm away from each other should be installed at refuge area to restrict the entry of any other vehicle at every pedestrian crossing on the whole stretch. Footpaths should be extended by 500 meters and raised platform of 100mm should be made around the trees and poles which can't be uninstalled near kacheri chowk.

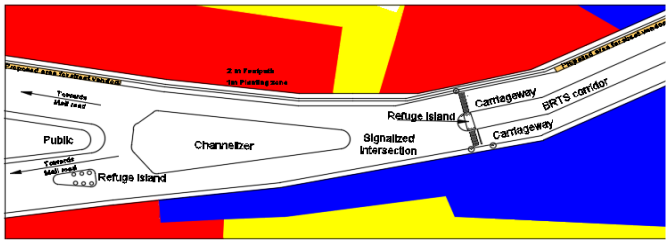
For Batala Road: Footpath width is adequate, but there is need to address the street vendors and vehicular parking. Mid- block crossings are to be provided at every 250-300 meter as per the standards according to the mixed land use nature along the stretch on the desired locations. Pedestrian signal should be looked after for its proper functioning on regular basis and so at celebration mall, they should immediately be fixed. Locations have been proposed for the installation of pedestrian signals at the stretch signages are to be installed 5 meters before every pedestrian crossing. There is a need for the designated place for the hawkers or

street vendors so that they would not encroach the footpath surfaces all over the stretch (Refer figure 17).

***Source*:** Internet

Fig 16: 3D Pedestrian crossing marking

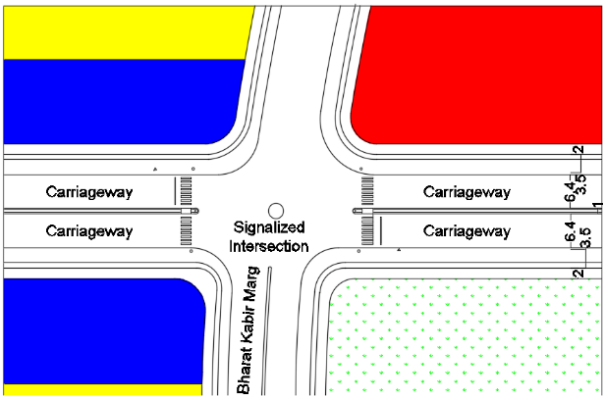
For Fatehgarh- Churian road: There is need to address the street vendors and vehicular parking. Locations have been proposed for the same. Also, obstructions such as electric pole, trees are to be grated from the grounded level up to 100m. Timely maintenance of the pedestrian marking, signals are recommended.



***Source*:** Computed Drawing

Fig 17: Detail at Celebration chowk

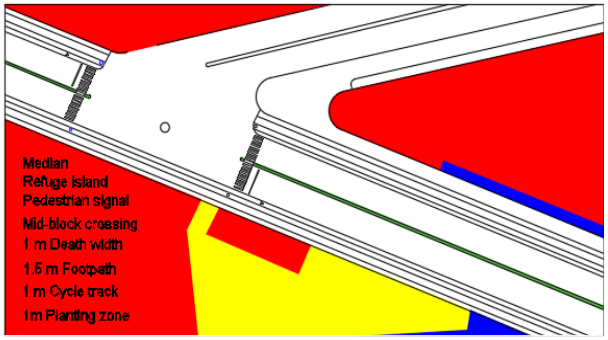
For Majitha road: The commercial can be shifted to a new location in order to make the footpath surface clear. Location has been marked for the same. The median cut out just outside the sacred heart school create chaos and children risk their life because of the heavy vehicular traffic during the school peak hours so it is suggested to close the same cut out and mid-block crossings are proposed at other location on the stretch. Pedestrian signals and signages are proposed to be installed. Provision of ramps are proposed in the footpaths for the disabled to access the same (Refer figure 18).



***Source*:** Computed Drawing

Fig 18: Detail near Sukhmani hospital chowk

For Ram Tirth road: It is recommended and proposed to provide footpath of width 1.5 meter on both the sides of the road followed by the 1meter bicycle track with separate multi-functional zone of 1 meter. Median of 0.5 meter is being proposed with 1meter dead width as the commercial nature of land use along the road Pedestrian signals and signages are proposed to be installed. Provision of ramps are proposed in the footpaths for the disabled to access the same (Refer figure 19).



***Source*:** Computed Drawing

Fig 19: Detail at Cantonment intersection

6. Conclusion

The very first measure need to be implemented in the city is to remove the unauthorized parking of vehicles as well as hawkers and to impose strict penalties on the violators. Adequate maintenance of the footpaths should be done timely. Universal applicability should be the priority for the future development and provision of ramps in the footpaths to be made on all the stretches for the disabled to access the same. Also, advertisements, campaigns, educational programs to be conducted in the city to make people aware of the importance of using pedestrian infrastructure. Violators should be strictly penalized whether they are hawkers, motorists or even pedestrians and cyclists not using their own spaces. For a congestion free city, equal importance and facilities to all types of commuters should be given.

References

1. WHO. Viewed 17, 2012.
2. DDA. Street Design Guidelines. Delhi: UTTIPEC.
3. IRC. Guidelines for Regulation and Control. New Delhi: Indian Road Congress, viewed, 1977.
4. IRC. Viewed, 2012.
5. IRC. Guidelines for Pedestrian Facilities. New Delhi: Indian Road Congress, viewed, 2012.
6. Jacobs J. The Death and Life of Great American Cities. America, viewed, 1992.
7. Master Plan Amritsar. (n.d.), viewed, 2019.
8. McLaren A. Economic Environmental Benefits of Walking Walkable Communities. Healthiest state initiative, 2016.
9. MoUD. (n.d.). Code of Practice for road markings, viewed, 2019.
10. Organization WH. (n.d.). Road Traffic Injuries. Viewed, 2019.
11. Otak. Pedestrian facilities guidebook. Washington State Department of Transportation, 2002.
12. Sachin Dass DS. Study of Pedestrian Flow/ Behavior on Indian Roads. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 2015, 38.
13. Solnit R. (n.d.). Wanderlust: A History of Walking, viewed, 2019.
14. UDD. Guidelines for Planning & Implementation of

Pedestrian Infrastructure. Directorate of Urban Land Transport, Govt. of Karnataka, 2014, 8-10.
15. UDD. Guidelines for planning & implementation of pedestrian infrastructure. Karnataka: Directorate, Urban Land Transport, 2014.
16. USreport Hr. (n.d.). The National survey of pedestrian and cyclist attitudes and behaviour, viewed,2019
17. UTTIPEC. (2009). Design standards and guidelines. New Delhi: DDA, 2019.
18. In safety, Wikipedia. (n.d.), 2019.
19. Google. (n.d). In Pune, http://smartcities.gov.in/upload/development/5a9009c9843cdPolicy%20for%20Pedestrian%20Facilities%20and%20Safety%20in%20Pune%20City.pdf, accessed on, 2019.
20. Google. (n.d.).In Amritsar, https://www.amritsarcorp.com/Tender/Reforms1819.pdf, accessed on, 2019.
21. Google. (n.d.). In Amritsar, https://www.mapsofindia.com/maps/punjab/roads/amritsar.html,accessed on, 2019.
22. Google. (n.d.). In Environment,http://www.indiaenvironmentportal.org.in/files/plan%20report%20new.pdf, accessed on, 2019
23. Wikipedia. (n.d.). In Research gate, https://www.researchgate.net/publication/303891478_Benefits_of_pedestrianization_and_warrants_to_pedestrianize_an_area, accessed on, 2019.
24. https://www.smartcitiesdive.com/ex/sustainablecitiescollective/pedestrian-only-shopping-streets-make-communities-more-livable/130276/, accessed on, 2019.
25. http://www.newurbanism.org/pedestrian.html, accessed on, 2019.
26. https://www.humankind.city/2015/12/woonerf-inclusive-and-livable-dutch-street/, Accessed on, 2019.