

Urge of Pedestrian Viability in Urban Context – Technological Intervention

Bhavya ravali¹
Meenakshi Pappu²

¹ Practising Architect, Chennai - 600037

² Associate Professor, School of Architecture, Vellore Institute of Technology, Vellore -632014, Tamil Nadu, India

Abstract. Studies have proven that the predominant urban pedestrian population plays a higher role where most of the trips start with a walk for a commuter and this makes it an important aspect to be considered in an urban area with an increasing population. There are issues like accidents on sidewalks and crosswalks due to a lack of sufficient pedestrian infrastructure and amenities. The evolution of technology has increased productivity by making life easier for people. Taking references from the successful models from developed countries and comparing them with parameters of Indian smart cities and the ‘Complete Streets Framework Toolkit’, to understand the integration of smart technologies to facilitate the increasing urban population in Anna Nagar of Chennai city. The increase in mobile use and the introduction of new 5G technologies facilitated in the urban context enhances the quality of infrastructure facilities for the urban population through safety, commutable, connectivity, and information knowledge.

Key words: Pedestrian Population, Smart Technologies (AI), Better Infrastructure, Safety and Security.

1. Introduction

India comprises a population of 1.38 billion in 2020 with an urban population of 34.93% in 2020[1]. The pedestrian population comprises of 33% [2] in which pedestrian related deaths are at 17.8% and accidents are 15.8% [3]. Growing technology plays a crucial role from the start to end of a day for every individual. Advanced technology has to be utilised for the safety and better development of urban pedestrian life. There is a necessity to connect urban design principles, urban infrastructure, and other Smart City standards developed by GOI with technological intervention to address pedestrian vulnerability.

2. Current Scenario of Urban Pedestrian Life

The urban growth rate and the infrastructure development in the urban core areas, and fringes are contrary. Due to this, the development couldn't reach all sectors of the infrastructure of road and its related urban spaces.

The below mentioned from (Table1) are a few identified scenarios, (Fig.1-6).

Table 1 : issues on footpaths

S. No	Topic	Issue
1	Footpath	Unpaved surfaces
		Insufficient width
		Parking encroachments
		Street vendors
		Lack of street lighting
		Obstructions like trees, poles, ducts, signages.
		Lack of dustbins
		Non- Barrier free design
		Pot holes
		Seating areas
		Poor maintenance
2	Crosswalks	Lack of zebra crossings
		Lack of signals
		Lack of signages
3	Bus stand	Improper placement
		Lack of signages
4	Technology	Lack of CCTV's
		Lack of solar generated street lights
		Charging points
		Lack of digital boards
		GPS locators

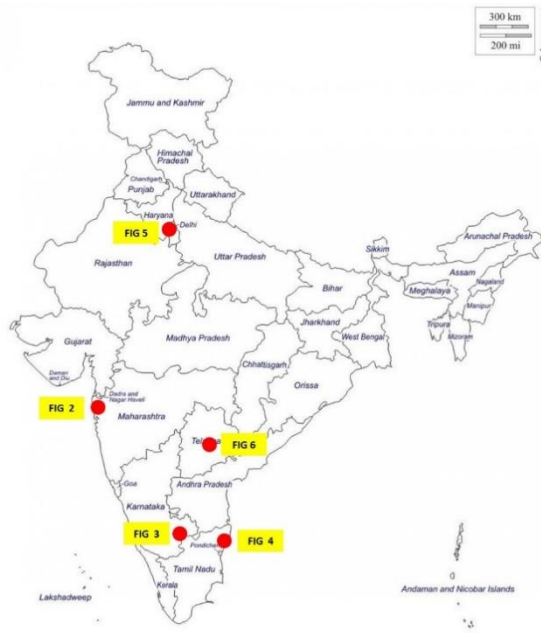


Figure 1 : Map showing below mentioned issues



Figure 3 : Potholes and broken footpath across the city, especially during rains, have put pedestrians' lives in danger. Pic: Meera K
Source: Bengaluru's deadly footpaths: Children, elderly at high-risk October 22, 2021 Ruchi Agarwal



Figure 2 : Existing pedestrian environment at Bellasis Road, Mumbai by Rohit Tak and Lekshmy Hirandas - April 21, 2020



Figure 4 : Pedestrians forced to walk on the carriageway at Konnur High Road, Villivakkam, Chennai. Pic: CAG
Source: CITIZENS MATTERS, Steps to make Chennai footpaths safe and comfortable for pedestrians June 25, 2021 Harish Baskar



Figure 5 : A footpath in Chandni Chowk, Old Delhi. Photo: Wikimedia Commons



Figure 6 : Encroached footpath and pedestrians are forced to walk into traffic-filled roads at Begum Bazaar, Hyderabad
Source: Hyderabad: The vanishing footpaths, Deccan Chronicle. | Maddy Deekshith, 2018

The studies have shown conclusive results that pedestrians while commuting on footpaths face significant psychosocial disturbances while on footpaths commuting. Only 7 percent of women felt that seamless footpaths were available throughout their city. 57 percent felt that their city did not have footpaths or were discontinuous and encroached and 35 percent perceived most or all their roads as dark. 74 percent of women and 78 percent of men wanted dedicated footpaths in their city [4] as shown in (Fig.7). The width of footpaths is less and heavy crowd movements create discomfort while walking for elderly people.

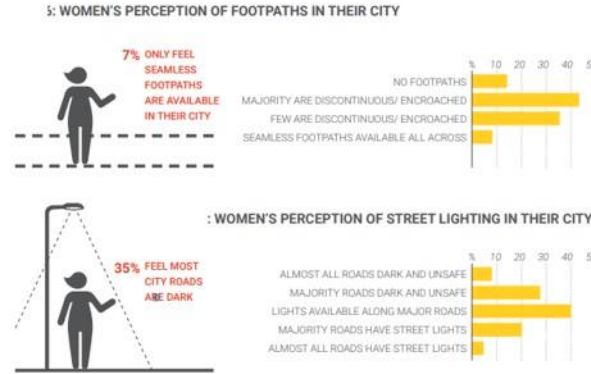


Figure 7 : women's perception on footpaths

Under the smart city, the program has initiated area-based development in Theyagaraya Nagar, a commercial hub of Chennai city. On the other hand, Anna Nagar, a highly dense residential area located in the metropolitan city of Chennai has been witnessing changes in facilitating pedestrian-friendly neighbourhood in the region. This paper focuses on major issues regarding the Anna Nagar region. A few of such urban infrastructure issues in the region identified are listed below:

- The width of the footpath to accommodate the pedestrian traffic
- The urban infrastructure design is to cater for all age groups of pedestrians
- Efficient lighting system for commuting during the dark hours on the footpaths
- The design to facilitate vendor, eateries, plantation & proper transaction pockets
- Digital technology integration into the urban facilitates
- The location has proper pavements, street infrastructure and footpaths with bus stops along zebra crossings near signal lights at the crosswalks.

The observations have led to other important issues pertaining to urban infrastructure but the scope of the paper is limited to the non-motorized traffic zones which address safe and commutable pedestrian-friendly neighbourhoods in the Anna Nagar region.

3. Methodology

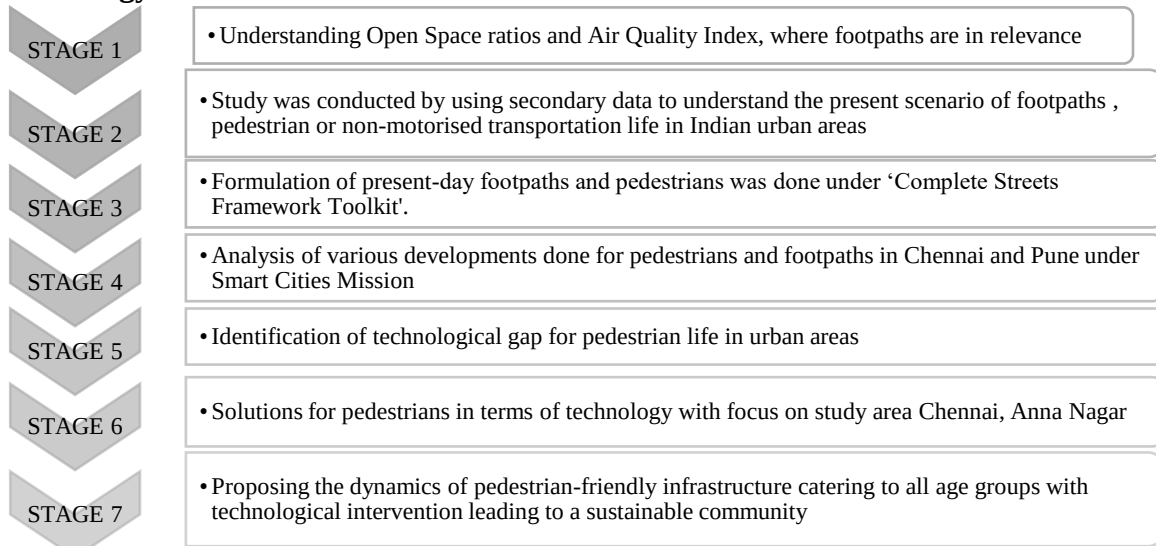


Figure 8 : Methodology

4. Literature study

4.1. Open Space Ratio and Air Quality Index

Urban Regional Development Plans Formulation and Implementation (URDPFI) guidelines, 2014 recommend 10 to 12 sq.mt. of open space per person in an urban area under the Ministry of Housing and Urban Affairs (MoHUA) department [5].

Table 2 : Existing scenario of Open Spaces in 4 Metropolitan cities of India 2022

Sl.no	Metropolitan City	Area in Sq.M	Population	Open space Ratio (Sq.M)
1	Delhi	700,000,000	32,226,000	21.7
2	Mumbai	603,000,000	24,973,000	24.14
3	Kolkata	206,000,000	18,502,000	11.13
4	Chennai	426,000,000	12,395,000	34.36

Above Table 2 helps us understand the present scenario of Open Spaces present in Indian urban areas in which it clearly depicts lack of Open Spaces [6].

The Central Pollution Control Board (CPCB), was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981. Air Quality Monitoring is an important part of the air quality management. The National Air Monitoring Programme (NAMP) has been established with objectives to determine the present air quality status [7].

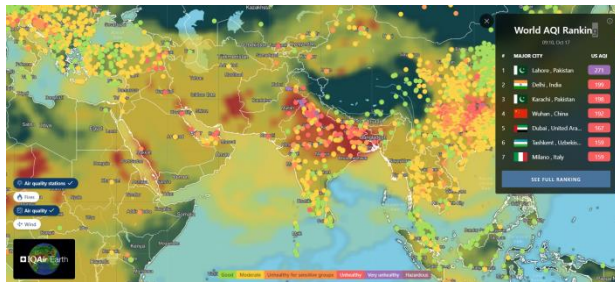


Figure 9 : Air Quality Index and Ranking worldwide

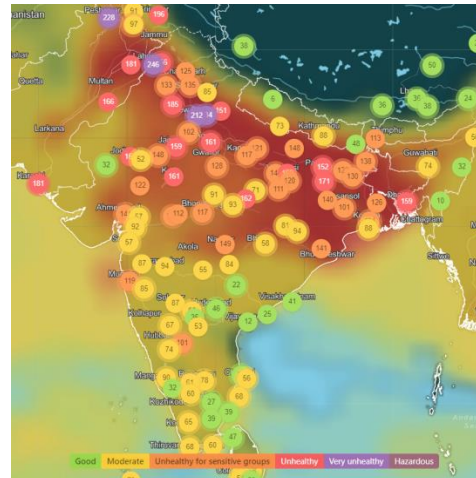


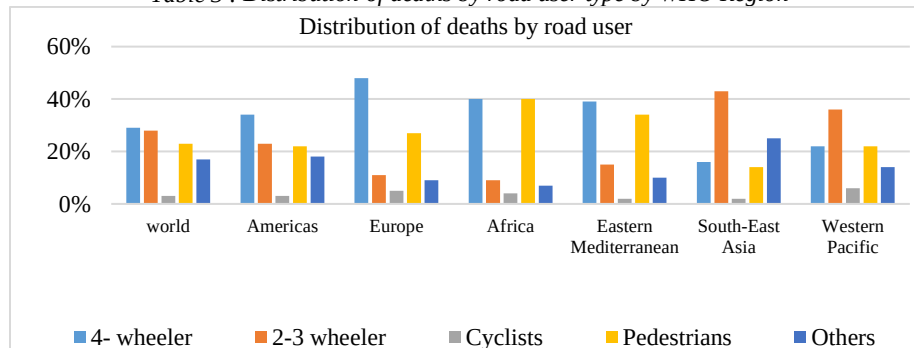
Figure 10 : Air Quality Index in India

(Fig 9-10) illustrate present AQI in world and India, this is in relation with open space ratio, as higher the open space value higher the AQI value, which is leading to many health issues.

4.2. Global Context

As per the World Health Organization, from the GLOBAL STATUS REPORT ON ROAD SAFETY 2018 [8], accident-related deaths, Globally, 26% of accident-related deaths are pedestrians and cyclists as per (Table 3).

Table 3 : Distribution of deaths by road user type by WHO Region



4.3. Indian Context

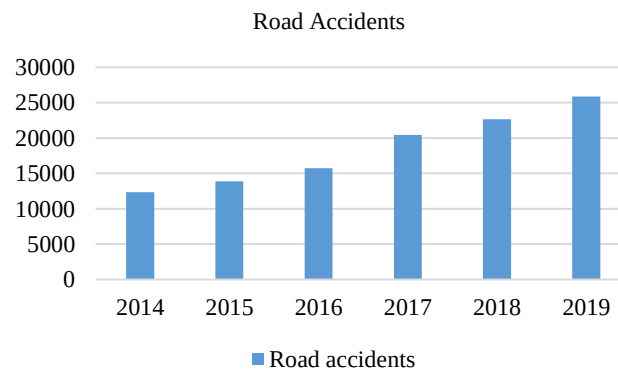
Thomas Harris McDonald [9], the father of the American interstate road system, once noted "*next to the education of the child, road building is the greatest public responsibility*". If the nation is equated to the human body, then roads are the arteries pumping life into it. India has one of the largest road networks in the world. These roads aren't for the motorized forms of transport but also for non-motorized forms of transport like pedestrians, cyclists, vendors etc. stated by Parijata Bhardwaj [10].

Indian cities are characterized by rapid urbanization resulting to congested streets with high vehicular traffic each year. Over the last two decades, transport planning in India has focused primarily on improving conditions for private vehicles at the expense of safe footpaths and cycling facilities [11]. As Walking, cycling and using public transport are the main ways of commuting in Indian cities nonetheless became unsafe and more hazardous in recent years. In fact, studies on pedestrianization by Wilbur Smith Associates for the Ministry of Housing and Urban Affairs (MoHUA) found that 28% of the population was estimated to be walking population [12]. According to the Road Accident Report of the Union transport ministry, 12330 pedestrians were killed across the country in 2014. The number steady rose to 13894 in 2015, 15746 in 2016, 20457 in 2017, 22656 in 2018 and 25858 in 2019 [13] as shown in (Table 4-5). Road fatality rates in India have surged to 20-25 times that of developed countries. With 56 pedestrian deaths and 10 cyclists' deaths per day, reported in 2017 by the Ministry of Road Transport and Highways, the streets in India are certainly not safe for its people [14].

Table 4 : Road accidents year wise in India

Year	No. Of Pedestrian Accidents
2014	12330
2015	13894
2016	15746
2017	20457
2018	22656
2019	25858

Table 5 : Road accidents in India



4.4. Government Stake on Indian Footpaths and Pedestrians

The Ministry of Housing and Urban Affairs, under the Smart Cities Mission, launched 'the Complete Streets Framework Toolkit' with technical inputs from ITDP India programme, on 26th February 2019, in New Delhi. It is aimed at guiding the 100 selected cities to prioritize walking, cycling, and public transport over cars, unlocking the inherent potential of the street space. In order to achieve this, the top 100 cities need to redesign and transform over 40,000 km of city streets into complete streets by 2030. Under this, several Indian cities are improving Pedestrian and Cyclist Infrastructure. For example, Tamil Nādu, a state with 12 cities selected under the Smart City Mission has allocated approximately Rs 2500 crores towards the implementation of 500 kilometres of complete street design projects, including Pedestrianization, Pedestrian Friendly Streets, and Intersection Design. Many cities have initiated work on redesigning their streets. Thus, a national-level document that serves as guidelines for the design of complete streets has been created [14] as shown in (Fig 11-16). The above statistics clearly depict India has a greater scope for NMT development. Parameters include pedestrian- friendly zones and enhance pedestrianization.

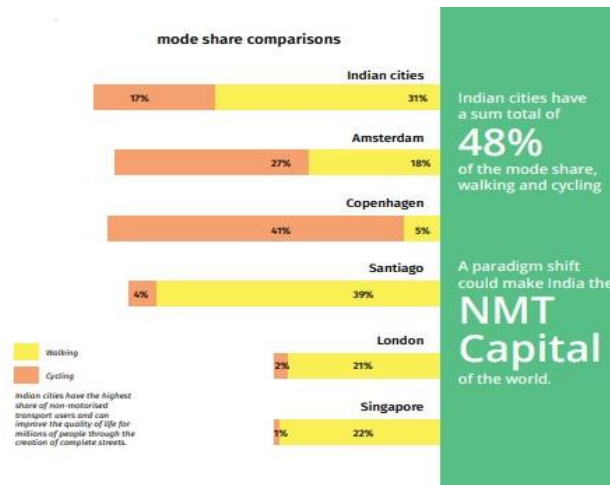


Figure 11 : Mode share comparisons globally

From the above (Fig.11) statistics it clearly depicts India has a greater scope for NMT development. Parameters which include in pedestrian friendly zones and enhances pedestrianization [1515].

4.5. Principles of a Complete Street

4.5.1. Efficient Mobility – It is ensured by offering multiple modes of travel, especially high-quality facilities for public and nonmotorized transport. With a greater capacity, a complete street moves more people by allocating space equitably for all users, and not prioritizing only the private motor vehicles as shown in (Fig.12). [15].



Figure 12 : Categorisation of street

4.5.2. Safety – A street should be safe for all user groups by providing segregated spaces for each and incorporating traffic calming measures. Ensures personal safety as well, with good lighting and ‘eyes on the street’ through active edges and vending. Along with reduced speed and safe crossings at intersections as shown in (Fig.13). [15].

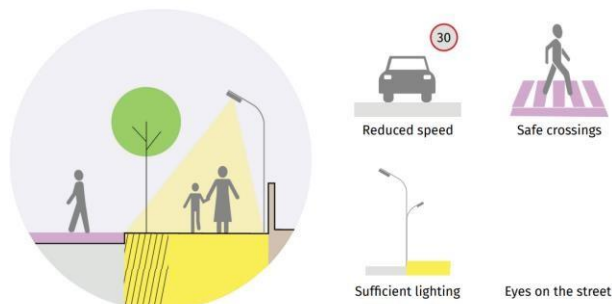


Figure 13 : Safety features of a street

4.5.3. Universal Accessibility – Streets Should be accessible by all, including the differently-abled. Continuous and even- surfaced footpaths, table top crossings and ramps and tactile pavers wherever level differences occur are some measures to ensure universal accessibility as shown in (Fig.14). [15].

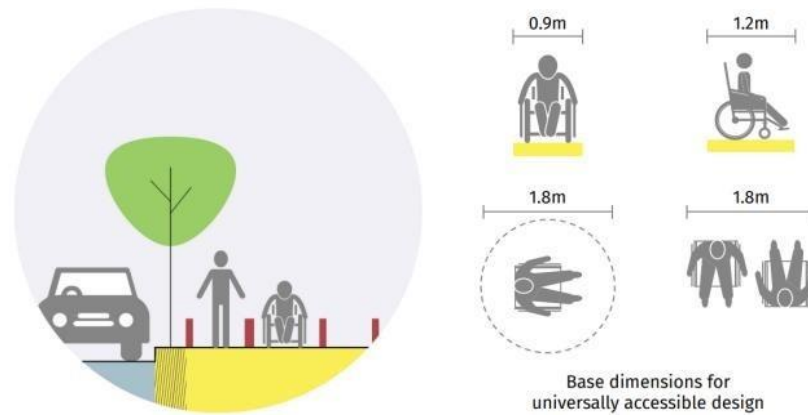


Figure 14 : Basic dimensions for universally accessible design

4.5.4. Livability – A Street is full of life, with elements that improve activity. Improved Livability improves conditions for existing users, attracts more users, increases retail activity and transforms the street into a vital public space as shown in (Fig.15). [15].

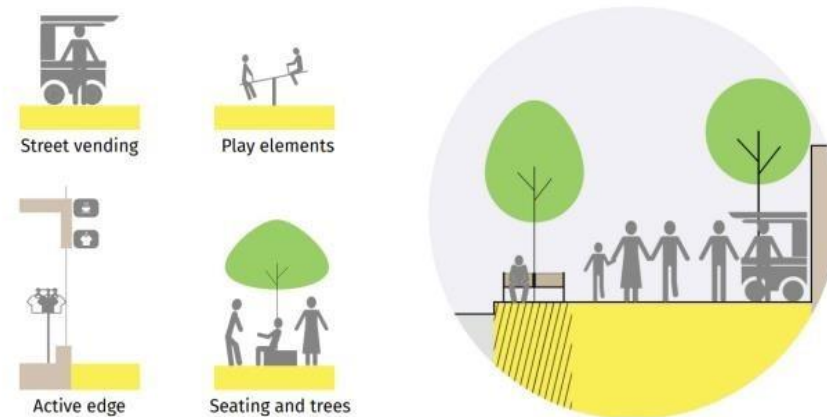


Figure 15 : Liveable factors on a street

4.5.5. Sensitivity To Local Context– Street is designed to suit the local context, factoring in local street activities, patterns of pedestrian movement, nearby land uses and the needs of the people. Design interventions can range from elements added to the street to street-level interventions like shared or pedestrianized streets as shown in (Fig.16). [15].

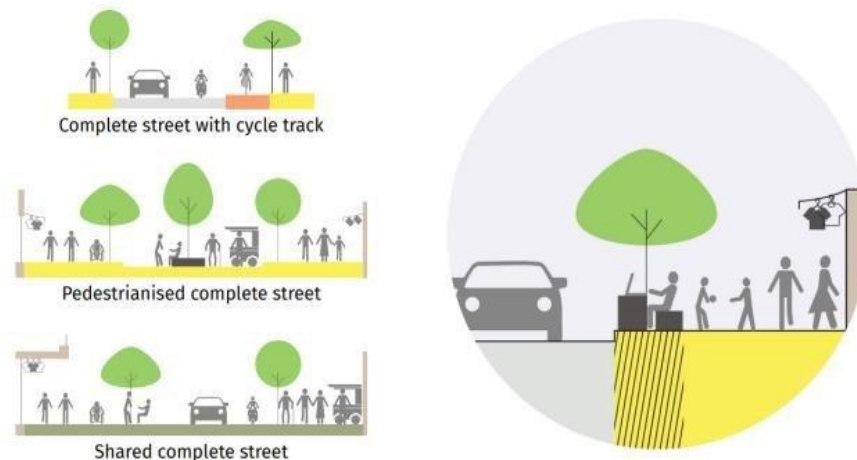


Figure 16 : Street designed to cater to the needs of all users and uses, through equitable allocation of road space

5. Analysis from Indian Smart Cities for Pedestrian Infrastructure

Cities like Pune and Chennai are extensively working on initiatives such as the Complete Streets project, to enhance accessibility and mobility and to introduce Indian cities to the concepts of high-quality footpaths, segregated cycle tracks, safe pedestrian crossing and regulated on-street parking [16].

5.1. Pune

Pune has been working to improve its pedestrian and cycling environment by redesigning its arterial roads as Complete Streets. 27km of streets have been identified for redesign, in the ABD (Area-Based Development) area as part of the Smart City proposal, and 100km under the city's annual budget [17].



Figure 17 : map indicating Pune



Figure 18 : The Jangli Maharaj or JM Road bustles with people and activity – a vibrant street indeed

Complete Streets are those that cater to all user groups – designed with wide and continuous footpaths, safe pedestrian crossings, separate cycle tracks where applicable, conveniently placed bus stops, clearly designated on-street parking, organised street vending and properly-scaled carriageways [17] as shown in (Fig 18-20).

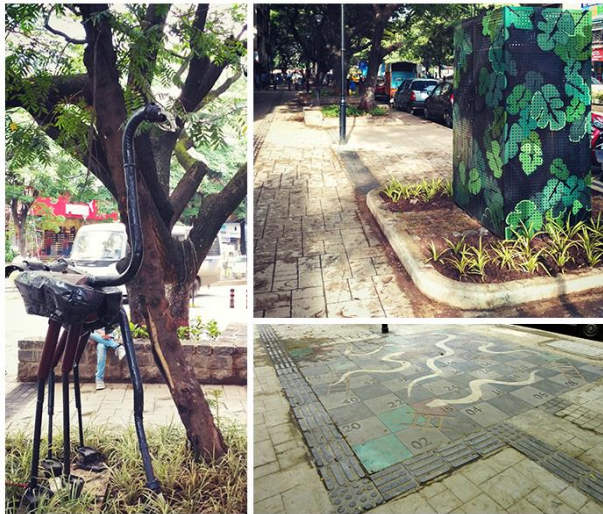


Figure 19 : Design features on DP Road: (clockwise from left) Art installations with recycled material; attractive casing covering up the junction boxes; play area for children

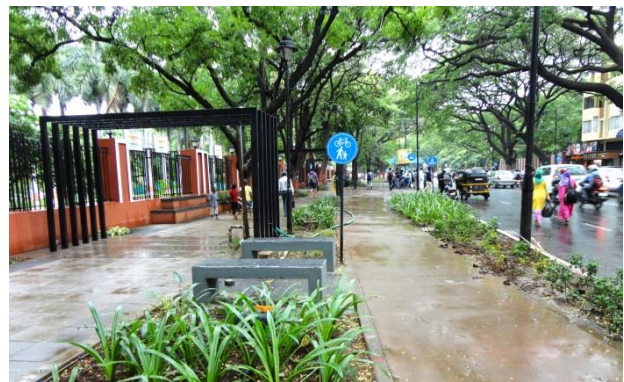


Figure 20 : Green spaces serve as buffers to segregate the two speeds of walking and cycling. Bus stops have been located so as to allow for smooth flow of pedestrians and cyclists.

Vendors now have dedicated spaces, as do children – play areas with rubberised soft flooring have been designed at regular intervals between the green buffers. Frontage of the shop's spill over to the wide footpath, adding life to the street. Better signage, street lighting and seating are other features that collectively make JM Road a stellar example of street design in the country [17].

5.2. Chennai

Special Projects Department, GCC and Chennai Smart City Limited has established a Pedestrian Plaza at Theyagaraya Nagar (T Nagar) with the aim of utilising additional road space to incorporate all essential pedestrian amenities and to create a traffic-free social space for the citizens of Chennai. The Pedestrian Plaza was envisioned to transform 1.4 km of prime commercial space in the heart of the Area-Based Development (ABD) region of T Nagar. The objective of the project was to provide all necessary amenities for pedestrians, including seating clusters, sheltered bus-stops, motor-free walkways, toilets, covered dustbins, inclusive play space and so on by converting additional road space into broadened walkways [18].

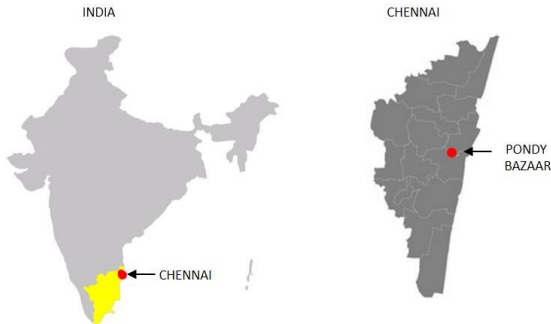


Figure 21 : Locational details of Chennai and Pondy Bazaar



Figure 22 : Area for the Development of Pedestrian Plaza, Pondy Bazaar

Some of the key design elements of the Pedestrian Plaza are Widened inclusive footpath, Vibrant seaters, Child-friendly play equipment, Lighting, Trees and planters, Utility design, Bicycle sharing [18] as shown in (Fig.21-26).

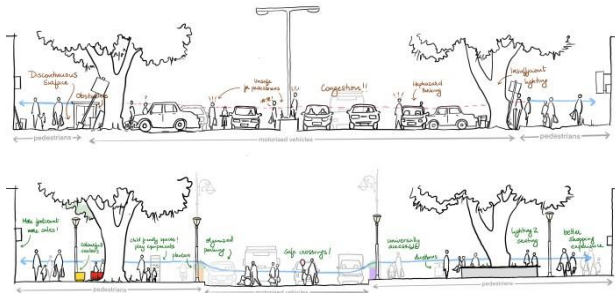


Figure 23 : above is before street and below one is the proposed street layout



Figure 24 : Pondy bazaar, Chennai, depicting various features of pedestrian plaza



Figure 25 : A play area at the Pedestrian Plaza, Pondy Bazaar



Figure 26 : Concealing of transformer with designer panels

6. Technological interventions on pedestrian's Life

In last 20 years technology has reached every house hold in urban areas. Of all the digital technologies, the mobile phone had the largest impact.

6.1. Drive in Smart Technology for Pedestrian Environment

Due to the digital divide, many people do not yet have access to digital technologies. A good smart city solution will not avoid this category along with pedestrian friendly cities as per Smart City Mission. It is important to implement smart city applications, and smart technology in consideration with all age groups of users for commuting for a sustainable community development. Along with making our streets safer for pedestrians and drivers, advanced technology is also making an impact on improving air quality and efficiency for commuters. Let's take a look at how some cities across the globe are utilizing technology to make their streets safer today.

6.2. Technological Interventions for Pedestrians in Developed Countries

6.2.1. New York City:

New York City is known for the grid-lock traffic, frequent pedestrian activities, and one of the most popular non-stop entertainment spots in the world. However, as New York and surrounding cities continue to grow, so does the incidents of traffic accidents involve pedestrians. To help improve the safety of their streets, Manhattan is implementing a million-dollar program called Midtown in Motion. This initiative will integrate cameras, field sensors, and FRID readers at intersections to communicate real-time data about a given area to residents and a central command centre as shown in (Fig.27). While this initiative is not new, it is part of a growing effort to make Manhattan safer for all visitors. One of the most innovative pieces of Midtown in Motion is that real-time data won't only be available to traffic engineers, but this data will also be accessible to drivers [19].

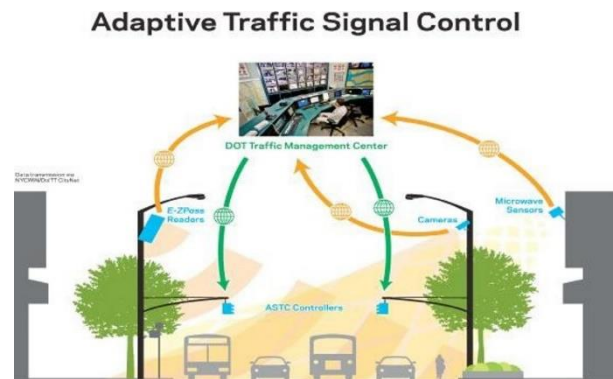


Figure 27 : Adaptive Traffic Signal Control

6.2.2. Sydney, Australia:

The geography of Australia is unique, as it has to push large pockets of residents together to build large cities in specific areas of Australia. As more people have congregated in these cities, Australia has taken innovative efforts to improve pedestrian safety throughout the urban environments. One of these initiatives is the Sydney Coordinated Adaptive Traffic System (SCATS). This innovative approach to traffic safety uses sensors and cameras on sidewalks to monitor traffic volume in a specific location at specific times. As these systems collect information about intersections throughout the city, a comprehensive real-time map of city traffic is created. This allows a central control system to find the right timing of lights to help coordinate pedestrian and vehicle traffic as shown in (Fig.28). SCATS has been improved to integrate other advanced technologies, but the system itself has proven itself as a useful tool to prevent pedestrian deaths. This method is being used around the world in large cities, including Shanghai, Hong Kong, Sydney, Mexico, Kuala Lumpur, Tehran, and Dublin. The most recent news about this is that Public Transport Information and Priority System (PTIPS), a new SCATS feature, The PTIPS is a real-time data platform that feeds all the transport apps, providing customers with bus, train, light rail and ferry locations. is being used in Sydney as a way to prioritize the late buses and make sure that everything is flowing smoothly. Based on the reports gathered, the use of SCATS has some benefits, and some of which are listed : The total stops decreased by 21%, The travel time reduced by 37%, There has been a 6% decrease in total carbon dioxide emissions, there has been a 5% decrease in total nitric oxide emissions, there has been a 10% drop-off in PM10 emissions [19].

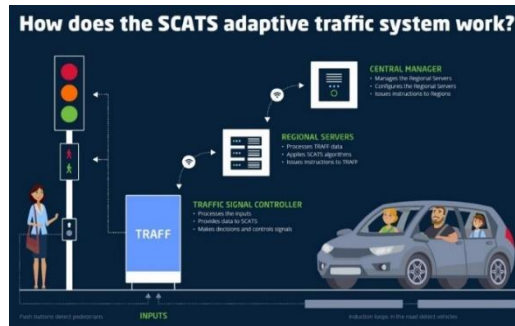


Figure 28 : Approach to traffic safety

6.2.3. Farmington Hills, Michigan

Michigan is one of the leading states implementing advanced technology to improve traffic safety throughout cities. One city, in particular, Farmington Hills, stands out as the leader in the advancement of pedestrian and traffic safety systems. Utilizing a network of modifiable and “smart” LED lights, city planners are making a connected system that talks to each other and optimize traffic flow. This interface is known as Intellistreets and continues to prove that improved traffic flow can drive economic factors of a city while also increasing safety and efficiencies across the city. The street lighting operates in a coordinated effect where each pole comes with its very own microprocessor that could work on its own, but could also line around a non-functioning unit. This system of smart LED lights allows authorities to project any message to help guide first responders and keep crowds safe around disaster areas. These poles also contain sensors and cameras capable of monitoring traffic flow that could tell which lights should brighten or dim down. The street names are visible in LED lights, as well as banners that could be modified to preview anything— this could range from traffic warnings, Amber Alert, directions, or even advertisements. Best of all, you can configure this in real time, and have it ready right away, making it ideal for events as shown in (Fig.29). Despite that the Intellistreets work well with traffic, its primary purpose is energy saving. It was created with pulse width transmission to ensure its energy efficiency when being used. For instance, dimming the lights of the Intellistreets would allow us to save 25% of energy and 25% less heat. Although we wouldn’t experience its benefits right away, after a time, it’s a wonderful investment as compared to a typical traffic light [19].



Figure 29 : Smart Street Light

7. Inference

From the case studies, there are few drawbacks in the design derived,

- Street vendors life is on footpaths where they make a living on that, but in the proposed toolkit and designed pedestrian footpaths there is no space allocation for street vendors, and it is important as they make a community living.
- There is no segregated cycle track on the pedestrian plaza.
- Pedestrian plaza is not a barrier free area as there is no tactile flooring.
- There is no safety at play areas in terms of flooring.
- There is no smart street lighting which will decrease energy consumption.

From the above, it is evident that there are developments happening in terms of pedestrian infrastructure yet it lacks with some features mentioned above. It also shows the importance and the gap of technological intervention in non-motorised traffic and infrastructure. The addition of technologies to these areas makes a huge difference in Chennai city development in terms of time, safety, liveability, sustainability and community living.

8. Proposals

As per the Analysis of 2 Indian cities under Smart City Mission for Pedestrian Traffic and Infrastructure of Chennai and Pune, we are taking Chennai in consideration and following are some existing scenarios and proposals exclusively on technological side (other infrastructure part is already done under smart city mission).

Chennai has an area of 426 km², with a population of 11,235,000 on 2021. Anna Nagar being a residential area [20] and its one of the most chosen residential areas to live in which is 8km from Chennai central.

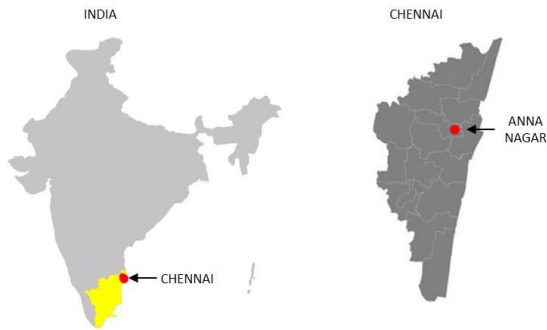


Figure 30 : Locational map of Anna Nagar



Figure 31 : Land-Use map of Anna Nagar area

- ❖ Footpaths are first and foremost spaces where pedestrians commute and Smart Street Light is the elemental feature for a footpath. This should be catered with intelligent systems such as solar generated light lamps, cctv with image sensors, concealed speakers for announcements, digital display board and signage, push button for emergency services like police /ambulance/fire accidents etc., paid Wi-Fi /internet facilities and paid charging points for mobile, laptops etc., Below example shows the present scenario of footpath existing in Chennai, Anna Nagar area as shown in (Fig. 32,33,34).

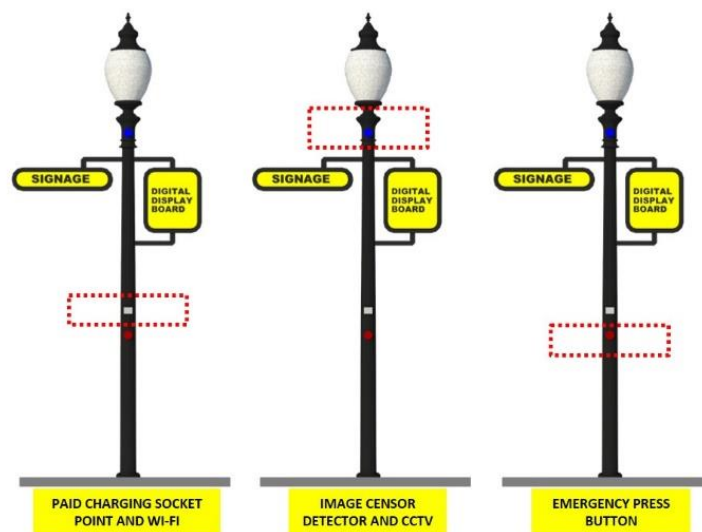


Figure 32 : Smart Street Light features



Figure 33 : existing footpath – on the way to VR mall, Anna Nagar, Chennai

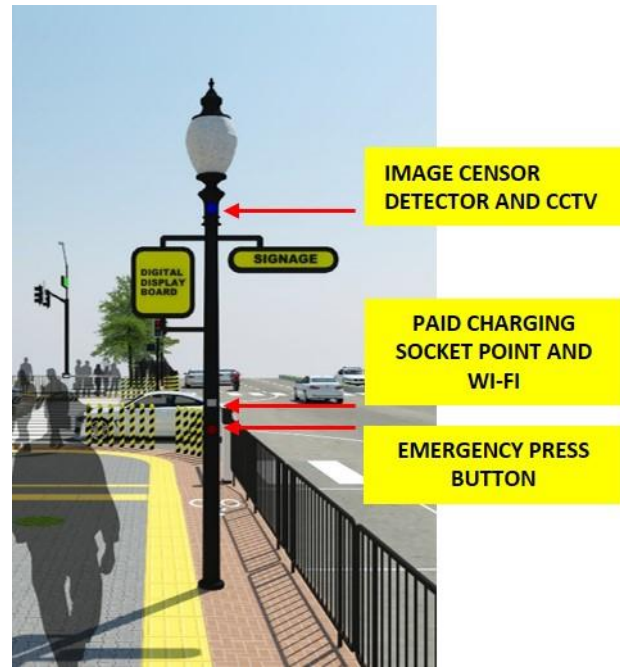


Figure 34 : Proposed Smart Street Light

- ❖ Smart Street Lighting should be designed with dimming of light levels as per pedestrian movement. This saves a lot of energy, reduces light pollution, also acts as a safety measure for women and reduces crime rate as shown in (Fig.35).



Figure 35 : Dimming of street lights

- ❖ Mobile application which allows to track current location of a commuter on streets with the help of location detector of smart street light, in turn aids government and family members to know the Geo-location. This enhances women safety and also reduces crime rate.
- ❖ Higher number of accidents crop up near crosswalks/junctions because of varied reasons such as crossing during the red signal for pedestrians, using of gadgets while crossing, etc.,



Figure 36 : Existing crosswalk at Anna Nagar area, Chennai.



Figure 37 : Proposed Crosswalk with censored Barrier Gate

From the above image (Fig.36), it depicts the present scenario of pedestrian movement at crosswalks which shows there are many probabilities for accidents and also with poor infrastructure.

Crosswalks with censored barrier gate makes commuters to cross safely and this censored barrier gate works with the presence of pedestrian traffic density and there is also a sensor which will send alerts on commuters' mobile application while crossing at crosswalks to avoid any sort of accidents as shown in (Fig.37-38).



Figure 38 : Alerts on mobiles/tablets while crossing at crosswalks

- ❖ Design of an application where commuters can use public transportation on their first choice. Existing case explains most of us do not prefer public transportation and one of the reasons is seat availability, so to solve this problem and make availability of seat to every commuter is book their seats, even with this ratio public transportation also can be altered. This helps in increasing public transportation and also reduces climatic adverse effects.
- ❖ There is a digital divide on considering all age groups and literacy rate, so taking this parameter, every bus stop should be designed with a digital touch display board where they can book their seats and check availability of intercity buses as shown in (Fig.39-40).



Figure 39 : existing scenario of bus stop in Thirumangalam area, Chennai.



Figure 40 : Proposed Digital Display Board for Bus Stop

9. Conclusions

The advancement in the field of technology and connection to digitalization by mobile users has been and will continue to grow. The wellbeing (physical and psychological) of urban communities is prioritised due to the raising urban population. This paper has focused on bringing in the connection between technology and urban infrastructure to give the urban population a safe and commutable pedestrian urban population in Non-Motorised Traffic (NMT). The technological interventions integration would enhance time management & smooth the transit. This would cater to addressing both the physical and mental health of the urban population. The scope of intervening of technology in the network of urban infrastructure fabric would enhance urban mobility to a greater extent through the Smart City mission.

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