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Evolution of Trends in Street Design and Shifting Mode Priorities

Vijaya Prasad[1], Sewa Ram[2]

[1]Research Scholar, Department of Transportation Planning, School of Planning and Architecture, New Delhi, 110002, India.
[2]Professor, Department of Transportation Planning, School of Planning and Architecture, New Delhi, 110002, India.

Abstract
Urban streets are essential to a city's structure, shaping its form and supporting diverse functions. Streets have had their evolution from serving to animal-drawn carts to facilitating military movements and eventually catering to cars and heavy motorized vehicles. However, as motorized traffic became dominant by the 19th century, the focus shifted to speed and vehicle flow, sidelining pedestrians and fostering car-dependent urban sprawl.
Since the 1980s, there has been a paradigm shift towards sustainable street development that prioritizes all users, including vulnerable and non-motorized traffic while ensuring their safety and inclusivity. This has been further reinforced by Sustainable Development Goals. Consequently, street definition and classification or categorisation have been changing over the years. Earlier much emphasis was on the inverse relation of mobility and access function of the urban street, proposed by earlier architect planners. The neo-traditional approach now balances flow and efficiency with the traditional street functions of supporting various other activities like markets, play, and leisure.
With this background, this paper examines the evolution of street design in various geographies with a focus on the American, European, and Indian contexts, based on an extensive literature review. The study examines the principles, and concepts that have been instrumental in the development of contemporary urban street environments globally. Finally, it illustrates how local governments can translate global sustainability aspirations into measurable, context-sensitive street designs through design transformation of a local street in Indian context.

Keywords: Urban street; Sustainability; SDG, Safety; Inclusivity; Vulnerable users

1. Introduction

Urban streets form the core of city life, influencing its organization and supporting diverse activities. Historically, streets evolved from paths used by animal-drawn carts to thoroughfares accommodating military and motorized vehicles. By the 19th century, the focus on vehicle-centric design often marginalized pedestrian needs. However, since the 1980s, there has been a notable shift towards sustainable street design that prioritizes all users, including non-motorized and vulnerable groups.
The United Nations' Sustainable Development Goals (SDGs), which were established in 2015, emphasize the creation of sustainable and resilient urban environments. Key targets related to urban streets include reducing road traffic injuries (Target 3), developing quality infrastructure (Target 9), and ensuring

universal access to safe, green, and inclusive public spaces (Target 11). The New Urban Agenda (2016) and the Sivelle Commitment (2019) stress the importance of localisation of these goals by involving local governments and stakeholders, in realizing these goals (Mwebesa et al., 2021; Morimoto et al., 2022; Giles-Corti et al., 2020).

This evolving focus is reflected in contemporary street design, which balances mobility, accessibility, and mode priority. Traditional approaches, which often centered on vehicular movement, are yielding to Neo-Traditional designs that integrate multiple functions and user needs. This modern approach seeks to create streets that are inclusive, sustainable, and resilient, addressing both historical limitations and current demands (Marshall, 2005).

This paper adds to the body of knowledge by presenting the evolution of street design with an aim to explore the foundational ideas and frameworks that have played a crucial role in shaping modern urban street environments around the world, and reasons which led to each street design paradigm change. The study's findings highlight how sustainable street design can foster urban environments with better accessibility, enhanced mobility, and greater social usability for diverse users. This will encourage planners, policymakers, and architects to more effectively address the challenges of urban street design, aiming to create streets that are sustainable, inclusive, and safe for everyone.

1.1 Methodology

The paper, grounded in a comprehensive literature review, is organised into five sections. The first section explores the historical evolution of urban streets tracing their development from ancient and medieval times to the post-world War II era. The second section talks about concepts and ideas related to new urbanism in the American and European regions. The third section examines on the evolution of urban streets in the Indian subcontinent. The fourth section draws inferences from the urban street evolution in the western and Indian subcontinent and talks about emerging trends in contemporary street design with a focus on sustainability, inclusivity, and safety. The fifth and final section synthesizes the study's outcomes, emphasizing the metamorphosis of a conventional urban street into a complete street.

Scholarly articles were collected primarily from academic databases such as Scopus, Web of Science, and Google Scholar. The literature included research articles, reviews, conference proceedings, and full-text articles published in English from 2000 to 2024. Additionally, gray literature such as books, documents, and guidelines were also considered. The search focused on key topics including urban streets (definitions, functions, hierarchy, patterns, classifications, concepts, design), sustainability (concepts, principles, SDGs, localization, implementation), and vulnerable road users (definitions, types, vulnerability, indicators, inclusivity, safety, accessibility, mobility). Keywords used in the search included: Urban Street, Safety, Inclusivity, Pedestrians, Women, Elderly, Children, Vulnerable Road Users, Urban Street Functions, Urban Street Hierarchy, Complete Streets, Walkability, Indicators, Composite Indicators, Safe Mobility, and Sustainability.

The relevant literature was selected by first manually screening the title, keywords, and abstract, followed by applying inclusion and exclusion criteria. In the second stage, a full content analysis was conducted to assess the relevance of the literature to the research topic, ensuring its inclusion in the final review.

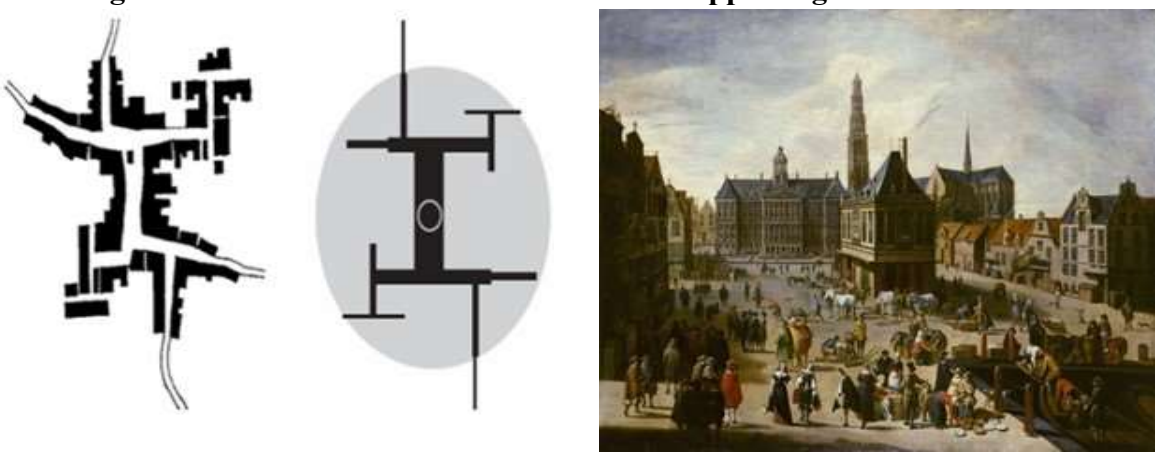
2. Historical Evolution of Urban Street

2.1 Ancient and Medieval Streets

Urban streets' evolution dates back to ancient and medieval times when it was the main activity area for the settlements, catering to both wheeled traffic which was usually drawn by animals and the same space

doubled up as a place where all the activities like market, entertainment, play area for children, gathering area for adults for exchange of news and views happened (Jain & Moraglio, 2014). This was facilitated due to slower speeds and human-scale development. Usually, the cities during these times centered around a square, market areas, castle, or other civic or religious centers with the main street leading to it in a radial, rectilinear or organic pattern (Marshall, 2005) as illustrated in figure 1. The wide throughfares in medieval period catered to the movement of military along while accommodating all other functions.

Figure 1 Historic Street with Central Core Supporting Diverse Activities



Source: Stephen Marshall, 2005, http://hdl.handle.net/11259/collection.38821

2.2 The Era of Grid Pattern - 18th and 19th Century

The industrialization of cities in the late 18th and early 19th centuries, marked by dense street networks, led to overcrowded, polluted, and unsanitary living conditions. Following the Industrial Revolution, cities expanded, and streets were designed to allow better access to air and light. With the introduction of motorized vehicles in the 19th century and later their widespread use, pedestrian safety became a concern, leading to the provision of sidewalks. Historically, the urban street has had basically two forms, grid and curvilinear with limited access. In the late 19th century, American and European cities were often designed with grid street networks. This design was favoured for its simplicity, dividing areas into square blocks with an orthogonal layout that facilitated movement and navigation. The grid design however, lacked the sensitivity towards addressing the topography of the area and orienting the buildings considering architectural climatology. This was evident in the design of San Francisco, where the grid even penetrated water in the bay area or in Philadelphia, Boston and New York (Rifaat, 2011; Wolfgang S.Homburger et al., 1989). Many early European cities (12^{th} -18^{th} century), from Wales to Florence, Mannheim in Germany, Edinburg, and much of central Glasgow, as well as many planned communities in Australia, Canada and the U.S., were built on a grid system. There were some differences in the grid designs of American and European cities. European cities, characterized by denser and more compact layouts with centralized land use patterns and controls, resulted in lower car dependency. In contrast, American cities were more dispersed, with lower densities and greater reliance on cars. This can also be demonstrated through Napoleon III‘s reconstruction of Paris during the mid-nineteenth century (Rifaat, 2011). He replaced the city's narrow streets with a grid-like network featuring wide boulevards. This redesign aimed to enhance connectivity between major activity areas and improve the environment by introducing green corridors and better air circulation. The concept

was developed by Georges-Eugène Haussmann, the chief architect of Paris's redesign.

2.3 Modernist Approach -Curvilinear Street Patterns - 19th to 20th Century

The grid pattern dominated urban streets in suburban areas even after WWII. In America, in the 1920s adverse traffic impacts of grid iron were addressed as these provided direct access to residential areas compromising safety. During the late 19th and early 20th centuries, new modernist ideas emerged in response to these issues. Notable concepts included Ebenezer Howard's Garden city (1902) and Le Corbusier's Radiant city (1933), which aimed to improve safety, air quality, and light compared to the traditional grid system. British planners Raymond Unwin and Barry Parker introduced cul-de-sacs and hierarchical street designs in their 1904 Hampstead Garden Suburb near London, based on Howard's Garden city concept(Porta et al., 2014; Rifaat, 2011; Wolfgang S.Homburger et al., 1989).

The garden city concept was later also formalised as a general design principle by Clarence Perry (1929) and used in North American cities. The concept featured neighbourhoods with clearly defined boundaries created by major streets connecting to internal roads primarily used for access. The center of each neighbourhood included open spaces and common facilities, all within walking distance from every part of the unit. Influential architects of the time, such as Lewis Mumford, Le Corbusier, Frank Lloyd Wright (Broadacre city), and Clarence Stein (Radburn), adopted this concept (Wolfgang S.Homburger et al., 1989). Street networks evolved to be more curvilinear, reducing connectivity on interior streets and appearing less monotonous and more natural than the traditional grid pattern.

Concerns about traffic and safety led Alker Tripp, a UK police official, to propose pedestrian-vehicular segregation through dedicated walkways in 1930 (Khairullina, 2018). Le Corbusier also addressed this issue in his radiant city, with high-density, residential skyscrapers connected through a network of grade-separated highways on a rectilinear grid. The highways being elevated the ground was to be used for pedestrian (Porta et al., 2014).

Both the Garden city and Radial city concepts were conceived to deliver a city with open space, urban growth boundaries and dense transit communities. However, these resulted in unintended effects such as residential sprawl on the city's outskirts, spatial and social segregation, declining services and commerce, reduced public life, and greater reliance on automobiles. The disconnect between neighbourhoods led to heavy traffic on the main streets, creating safety hazards for pedestrians.

The first formal planning guide addressing these issues was introduced by Collin Buchanan in 1963 (Liu et al., 2017; Rifaat, 2011). Buchanan distinguished between roads serving heavy traffic and those providing access to properties, thus reversing the historic focus on central accessibility and distributing it around the urban periphery. Both Buchanan and Alker Tripp aimed to enhance road safety through the segregation of pedestrian and vehicular traffic however, the practical application of their concept often led to traffic-dominated outcomes (Porta et al., 2014). Table 1 summarises sections 2.2 and 2.3.

Table 1 Comparison of Grid and Limited Access Street Designs

Feature	Grid	Limited Access-Cul-de-Sac, Hierarchical
Safety	More Intersections lead to more collisions. More access to private property against CPTED Principles	Hierarchical street network eliminates through traffic in cul-de-sac and side streets but increases the volume and speed of vehicles on a collector street
Connectivity	Rectilinear design, alternate path for diversion, high degree of efficiency	Reduced connectivity on interior streets, quiet and safe streets

	and reliability	
Travel Time	Straight-path travel is possible which often reduces travel time and cost	More Travel time
Ease of Orientation	Offer simplicity, ease of navigation, and logical layout, but can be monotonous and encourage higher speeds	Provides aesthetic appeal and distinctive navigation cues but can be confusing and less predictable.
Sociability	Sidewalks on both sides allow pedestrian activity throughout the neighborhood.	Cul-de-sac and bays allow children to play in the front yard and street without being endangered by fast-moving traffic. Promote familiarity and neighborliness.
Cost	Costlier as more paved area	Reduced standards for street widths, sidewalks and curbs, thus cost is lower
Examples	Grids or grid-like patterns were established in many early American cities, including New York, Philadelphia, Washington, and Savannah.	Eg.-Radburn, New Jersey in 1928, reduced street area and the length of utilities, such as water and sewer lines, by 25 percent
Time Period	Dominated Pre WWII era - Thoroughfares carrying Goods and People with min Delay	Post WWII (Garden city Movement) Curvilinear, cul-de-sacs and loops, commonly refer to a dead-end street.

2.4 Late 20th Century Onwards - Paradigm Shift

New urbanism or Neo traditional approach

Upto the mid-19th century, street design was dominated by concerns of traffic flow and speed while ensuring the safety of pedestrians. This was achieved by separating these elements, with highways and arterials prioritizing movement function and internal lower hierarchy providing access to the adjoining property, with low traffic and few intersections to discourage heavy/through traffic. This curvilinear, disconnected street network resulted in sparse development and isolated neighborhoods that could only be accessed by vehicles.

However, many planners and social thinkers began challenging these urban development principles and advocating for streets that serve diverse user groups. Jane Jacob (1961), American-Canadian journalist and author, argued for mixed-use spaces that promote community interaction and safety through “eyes on the street” (Gómez De Salazar et al., 2020; Jacob, 2016). Donald Appleyard (1981), English-American urban designer and theorist, highlighted the inverse relation between traffic flow and levels of liveability (Rifaat, 2011). These were some of the first attempts to question the inclusivity aspect of street design. Appleyard gave the idea of livable streets, advocating acceptable level of traffic speed and volume, along with prioritising pedestrian right-of-way (Meetiyagoda & Munasinghe, 2009). Allan Jacobs (1993), American Architect Planner, compiled a list of essential qualities for great streets, including places for leisurely walking, physical comfort, visual engagement, transparency, and quality of construction (Wolfgang S.Homburger et al., 1989; Meetiyagoda & Munasinghe, 2009). figure 2 illustrates the contributions of various thinkers and planners of the time.

Thus, Since the 1970s and 1980s, there has been a shift in street design, with greater emphasis on the

movement of people rather than vehicles. Concepts aimed at reclaiming pedestrian priority emerged, such as the "woonerf" introduced in the Netherlands. This design creates a “living street” or “shared space” with a uniform pavement that integrates pedestrians, cyclists, and vehicles in a safe, interactive environment without grade separation. Vehicles must navigate carefully through narrow sections, accommodating various street activities.

Another more widely accepted concept in the inclusive and safe design for diverse users is the “Complete Street Concept”. The early influencers of the concept were Jane Jacobs, 1960 and Jan Gehl, 1970-80. The concept was formalized by David Goldberg with the formulation of the National Complete Streets Coalition in the USA in 2005.

The policy development was done by the National Association of City Transportation Officials, United States, (NACTO), which published guidelines for the development of complete streets in the US and internationally (the Urban Street Design Guide 2013). Similarly, the UK Manual for Streets (United Kingdom), published in 2007, provided comprehensive guidance on stret design that prioritizes pedestrians and cyclists, reflecting Complete Streets principles, which was adopted widely in the UK.

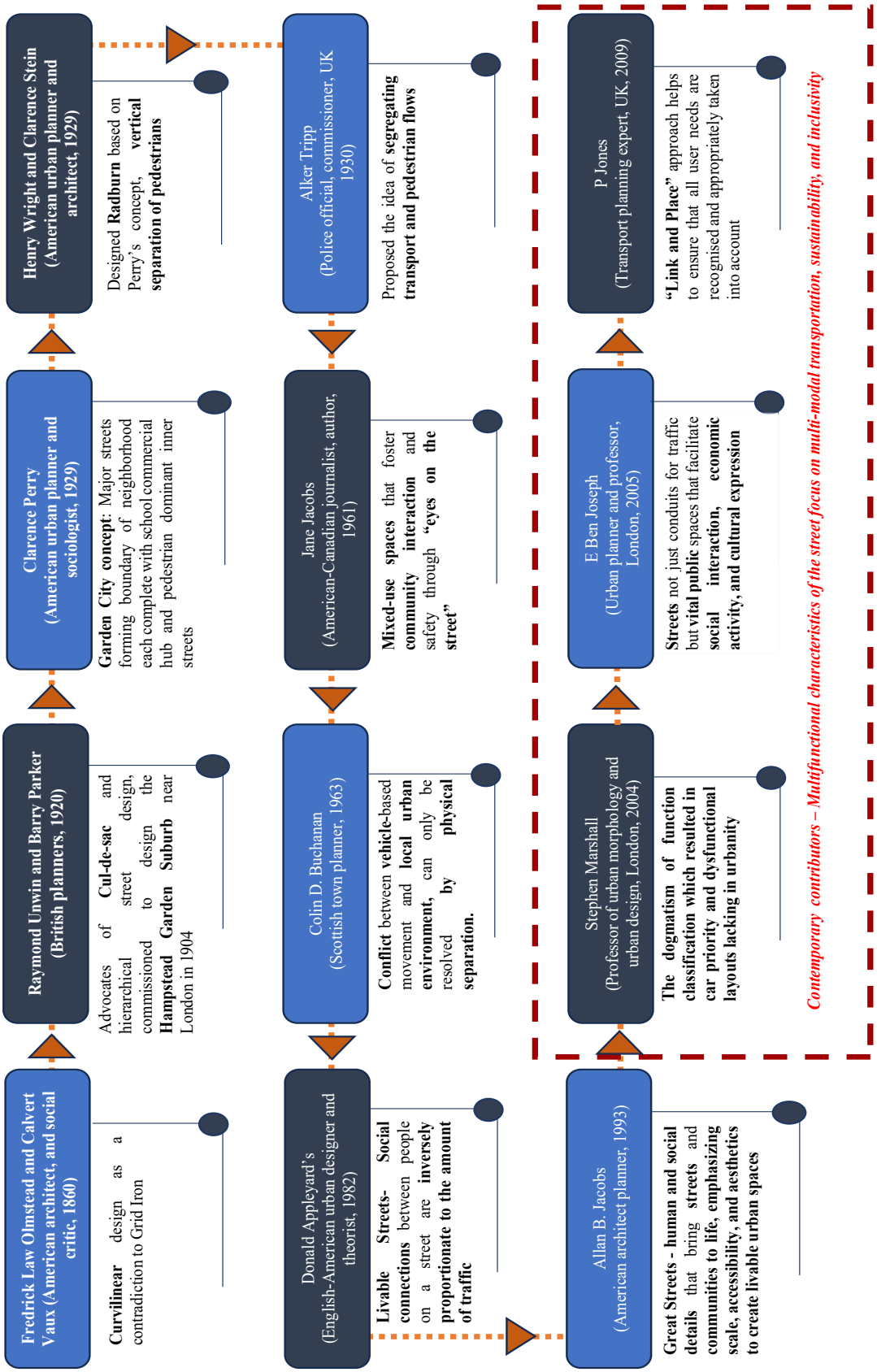
This has sparked the street design principle change across the world. Many cities and states have pledged to safeguard the rights of vulnerable road users concerning urban street usage. Copenhagen's long-standing commitment to cycling infrastructure and pedestrian-friendly design has made it a model city for Complete Streets. Vancouver has been a leader in North America for its progressive transportation planning, which includes extensive bike lanes, pedestrian zones, and public transit integration, aligning with Complete Streets concepts. Melbourne's urban planning initiatives have focused on creating more walkable and livable streets, incorporating public spaces, and prioritizing pedestrian and cyclist needs in its central business district. Many European cities have adopted Sustainable Urban Mobility Plans (SUMPs), which emphasize multimodal transport and Complete Streets principles, fostering safer and more sustainable urban environments (Sosik-Filipiak & Osypchuk, 2023).

Bogotá (Colombia) under Mayor Enrique Peñalosa in the late 1990s and early 2000s included significant improvements in pedestrian and cycling infrastructure, public transit, and public spaces, aligning with the ethos of Complete Streets.

In Asia, Japan has emerged as a leader in compact city models that emphasize mixed-use development, walkable areas, and efficient public transit. Cities like Tokyo and Yokohama have effectively implemented Complete Streets concepts through urban planning that supports non-motorized transport and universal design principles, ensuring accessibility for all, including children, the elderly, and those with disabilities. Singapore's Land Transport Master Plan (LTMP) enhances public transport, walking, and cycling infrastructure to reduce reliance on cars. Initiatives such as the Park Connector Network (PCN) offer safe routes for pedestrians and cyclists, while the Active Mobility Act promotes the safe use of personal mobility devices and bicycles, further advancing Complete Streets principles.

In China, cities like Beijing and Shanghai have created extensive networks of greenways and bicycle lanes as part of efforts to reduce air pollution and encourage active transportation. China’s National Urbanization Plan emphasizes sustainable development and Complete Streets principles, promoting public transport and non-motorized options.

Figure 2 The Major Contributors and Concepts



Source: Author

2.5 Indian Context – Street Developments

India, a vibrant and culturally rich nation, has a long history of urban development and settlements. Indian urban streets have historically supported various functions related to access and mobility for both private and public activities. The earliest human settlements on the Indian subcontinent date back to around 2800 BC in the ancient cities of Harappa and Mohenjo-Daro of the Indus Valley Civilization, where a grid pattern of long, intersecting streets was discovered as illustrated in figure 3.

Figure 3 Streets of Mohenjo-Daro

Streets of Mohenjo-Daro

Mohenjo-Daro city plan

Source: https://www.oldindianarts.in

During the Mughal era, urbanization and road development played a significant role in cities like Delhi, Agra, Lahore, and Fatehpur Sikri. The Mughals built roads for administrative, economic, and military purposes. Sher Shah Suri established the renowned GT Road, which connected the eastern and western parts of the empire, facilitating trade and movement. Mughal cities were meticulously planned, with central markets, bazaars, and administrative buildings. Local streets included broad bazaars for trade and narrow, winding residential streets reflecting organic neighborhood growth. Notable examples include Chandni Chowk in Delhi, with its wide processional streets lined with buildings, gardens, and fountains enhancing aesthetic appeal (Iftikhar, 2018).

In the 1830s, the British East India Company initiated metalled road construction, leading to the establishment of the Public Works Department and the Indian Institute of Technology Roorkee for training professionals. The Indian Road Congress (IRC) was formed in 1934 to oversee systematic road development, introducing metalled roads, wide thoroughfares, colonial commercial streets, and grid-patterned residential streets. The Nagpur Plan guided road planning across India, incorporating features such as bridges, overpasses, roundabouts, and public squares (Wadhwani, 2021). figure 4 illustrates urban streets in Mughal and British era.

Figure 4 Urban Streets in Mughal and British Era

Source: https://www.oldindianarts.in/2012/03/illustrations-from-book-india-1876-part_11.html?m=1

2.5.1 Post-Independence Developments

Urban street development in India has evolved significantly from ancient times, now focusing more on sustainability. Urban roads in India make up only 9% of the total road network, compared to 30% in the USA (Wadhwani, 2021). With approximately 8,000 towns and cities (Mistelbacher & Kumar, 2013), India faces challenges due to unplanned expansion, often around riverbanks and transport hubs, leading to congestion and pollution. The 74th Constitutional Amendment (1992) granted Urban Local Bodies (ULBs) responsibility for urban transport, but financial limitations persist (The Constitution (74th Amendment) Act, 1992, 1992). To address these issues, the Indian government launched the "Smart Cities Mission" in 2015 to foster sustainable and inclusive urban environments through smart solutions. Additionally, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) supports urban infrastructure development, including non-motorized transport and public spaces.

The Complete Streets concept is being promoted under these missions, with guidelines developed by the Ministry of Housing and Urban Affairs (MoHUA), technical institutions, and NGOs. Key principles include pedestrian-friendly design, dedicated cycle lanes, seamless connectivity, universal accessibility, green infrastructure, and traffic calming measures. Frameworks such as the Indian Roads Congress (IRC) Guidelines (*IRC 086 -2018*, 2018; *IRC:SP:118-2018*, 2018), Unified Traffic and Transportation Infrastructure Centre (UTTIPEC) (Street Design Guidelines, UTTIPEC, 2009), and Complete Street Planning workbook by ITDP guide the development of urban street infrastructure including complete street developments (Complete Street Best Practices, 2019).

2.5.2 City-Level Initiatives

As a capital and a smart city, Delhi has multiple agencies working on urban street improvements. Mohua, Delhi Development Corporation (DDA), and Delhi Urban Arts Commission (DUAC) are leading street redesign projects to alleviate traffic congestion, enhance road efficiency, and integrate spaces for vehicles, pedestrians, and non-motorized transport (*Street Design Guidelines*, 2020). These projects also focus on adding green spaces and improving accessibility for people with disabilities.

Pune: The "Pune Streets Program" focuses on creating safe, inclusive streets with detailed guidelines for pedestrian pathways and cycling infrastructure.

Chennai: The city is prioritizing non-motorized transport with wider footpaths, dedicated cycle lanes, and improved public transport access.

Bengaluru: The Directorate of Urban Land Transport (DULT) promotes Complete Streets concepts

through initiatives like TenderSURE, ensuring safe and efficient street design. City-level initiatives in India are illustrated in figure 5 (Complete Street Best Practices, 2019).

Figure 5 City Level Initiatives in India

Aurobindo Marg, Delhi, sub arterial lane

Jungli Maharaj Road, Pune

Bengaluru Planetarium Road

Racecourse Road Chennai

Source: Author, Streets for People-Pathwyas of change from India's Smart cities, MoHUA, Dec 2023

3. Morphological Trajectories towards Complete-Street Urbanism

3.1 Street Design Concepts

The Present day challenge is to design urban streets that balance transportation efficiency and safety while accommodating diverse modes of travel and maintaining the traditional street functions (Marshall, 2005; Tsigdinos et al., 2024).

The development of urban streets has undergone significant morphological changes, evolving in response to the transportation needs of different eras-from ancient and medieval times to modernist and new urban periods. Neo-traditional developments, commonly referred to as - "New Urbanism" are defined by higher densities, mixed land uses, public transit access, accommodation of pedestrians and bicyclists, and a more interconnected street layout.

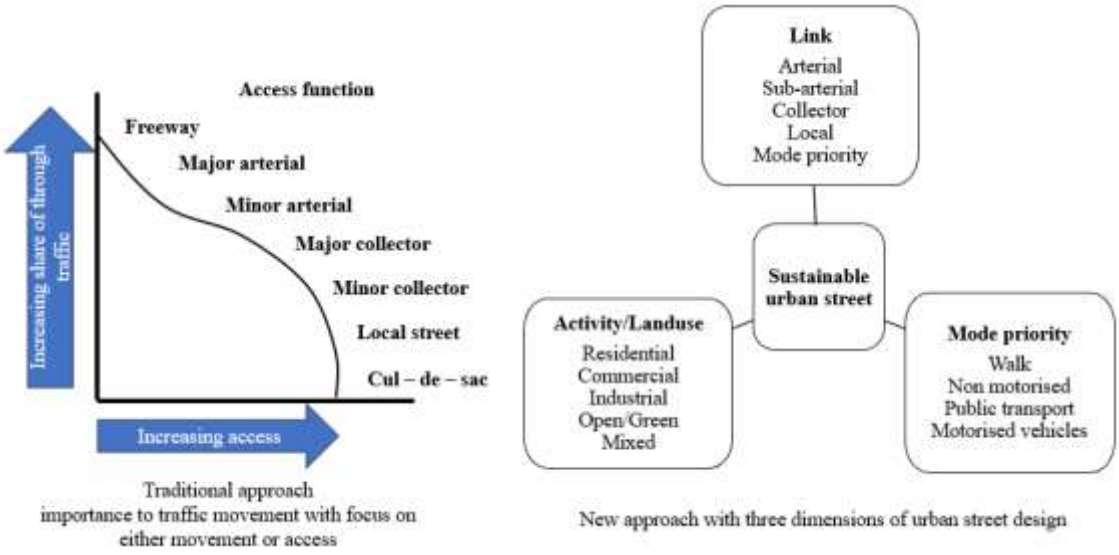
Traditional hierarchical classifications, such as Freeways, Arterials, and Collectors, have often prioritized vehicle traffic, resulting in a separation of pedestrian and vehicular spaces. However, urban street design now requires a broader classification that addresses multiple functions and user needs.

This idea has further been translated into street design by moving away from single-dimensional approach which mainly focuses on traffic movement. The two-dimensional street design approach focuses on the "Link" and "Place" functions of an urban street. The link function represents movement and the place function represents the activity and both are assessed for a given street (Peter Jones et al, 2008). A trade-off between the two functions based on capacity or availability of space can be worked out for each street in an urban setting, with each function getting its due minimum or desirable share. The Manual for Streets

UK (Manual for Streets 2, 2010), has been based on this principle and reflects the two-dimensional street design approach.

Another approach talks about the three-dimensional street design standards (Liu et al., 2017). In this approach in addition to the activity and movement function the mode priority is also considered as a dimension of street design. The road network is considered to support all modes with equal priority. Each mode has distinct movement and access needs, with differences in travel range. Right-of-way arrangements can be optimized for each mode based on its own hierarchical networks and the overlying network considering all modes. This approach allows for a road system that prioritizes pedestrians, transit, and non-motorized vehicles (NMVs). Figure 6 demonstrates single, two- and three-dimensional street design concepts.

Figure 6 Traditional and Multi-Dimensional Street Design Concepts



Thus, each road can be classified as an integrated category by considering hierarchy, frontage activity, and mode priority. This approach allows for a diverse range of road types with three-dimensional combinations, such as a “local-scenic-NMV and pedestrian priority" road, or an "arterial-commercial-bus priority". Table 2 shows street guidelines based on the multifunctional street design concept (Abu Dhabi Urban Street Design Manual Vision 2030, n.d.; *Manual for Streets 2*, 2010; NYCS Treets Plan Update2024, 2009; Urban Street Design Guidelines[R], Charlotte City, 2007).

Table 2 Street Guidelines Based on Multifunctional Street Design Concept

Guideline	Street Classification	Focus
Street Design Manual, NYC DOT, 2009	General Street, Boulevard, Slow Street, Transit Street, Pedestrian Only Street	Considering the right combination of land uses and streets to facilitate planned growth
Urban Street Design Guideline, Charlotte city	Main Street, Local Street, Avenue, Boulevard, Parkway	Streets were divided into five categories- “main street, local street, avenue, boulevard and parkway”, considering the right combination of land uses and streets to

Guideline	Street Classification	Focus
Council, 2007		facilitate planned growth
Abu Dhabi Urban Street Design Manual, AD UPC, 2010	Street Family (Boulevard, Avenue, Street, Access Lane); Transport Capacity (Veh Priority, Travel Lanes); Landuse Context (City, Town, Commercial, Residential, Industrial, No Active Frontage)	Two name conventions, the first name, the "Context name," is based on the urban land use, such as "Residential" or "Commercial". The second name, the "Street Family name," refers to the transport capacity of the street.
Manual for Streets UK	"Streetscape Guidance", including "urban civic, retail and commercial; urban residential; suburban commercial and industrial; suburban residential; suburban and rural fringe", as well as some special areas such as "transport interchanges, town center high streets and heritage areas and features, nature conservation sites, open common and parkland"	High-quality streets with a focus on the balance between place and movement function instead of assuming 'place' to be automatically subservient to 'movement'. Manual for Streets does not address in any detail the planning of the whole urban street network nor how to design appropriately for competing street uses on the busier sections of the street, where space is limited.

3.2 Sustainable Urban Street Development

Sustainability in urban street design focuses on space, speed and priority management which can ensure improved accessibility, and better social usability focusing on diverse user groups and quality of life through safer mobility (Mwebesa et al., 2021), as illustrated in figure 7. An important aspect of this is involvement of stakeholders so that the final outcome is acceptable by all.

Figure 7 Space-Speed Priority Management-Sustainable Street Development

Source: Author

Space, speed, and mode priority are integral to the two and three-dimensional street design guideline that encompasses mode priority, hierarchy, and activity. Here's how these elements can be linked:

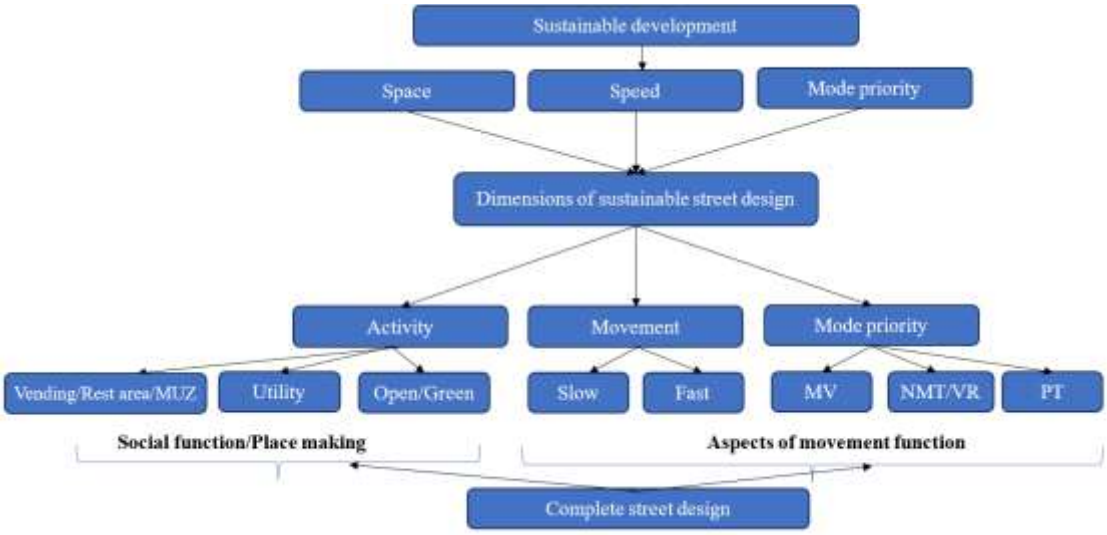
1. Space: Street design must allocate space effectively to accommodate various modes of transportation and activities. This involves defining the physical dimensions of the street to ensure sufficient space for vehicles, pedestrians, cyclists, and other users. In a three-dimensional design, space management addresses the horizontal and vertical allocation of roadways, sidewalks, bike lanes, and public spaces, ensuring that each mode has adequate and safe space.

2. Speed: Speed influences how streets are used and perceived. In two-three-dimensional street design, speed regulations and traffic calming measures are incorporated to manage how quickly different modes of transportation can move through the street. This affects the design of roadways and intersections to ensure safety and efficiency. For example, lower speed limits may be implemented in areas with high pedestrian activity to enhance safety and comfort.
3. Mode Priority: Prioritizing different modes of transportation impacts the design of the street. In a three-dimensional design guideline, mode priority determines how space is allocated and how infrastructure is designed. For instance, streets may be designed with dedicated bike lanes and wide sidewalks in areas where cycling and walking are prioritized, while lanes for motor vehicles might be narrower or subject to traffic management measures.

3.3 Complete Street Concept

The Complete Streets concept aligns closely with the principles of sustainable development, incorporating space management, speed regulation, and mode priority into its framework, it talks about giving equal value to social function and mobility function (Mofolasayo, 2020). Thus, it is a tool to implement the SDG-oriented design (SDG:3,9,11) (Giles-Corti et al., 2020) catering to all the dimensions of street design as illustrated in figure 8.

Figure 8 Sustainable Development and Complete Street

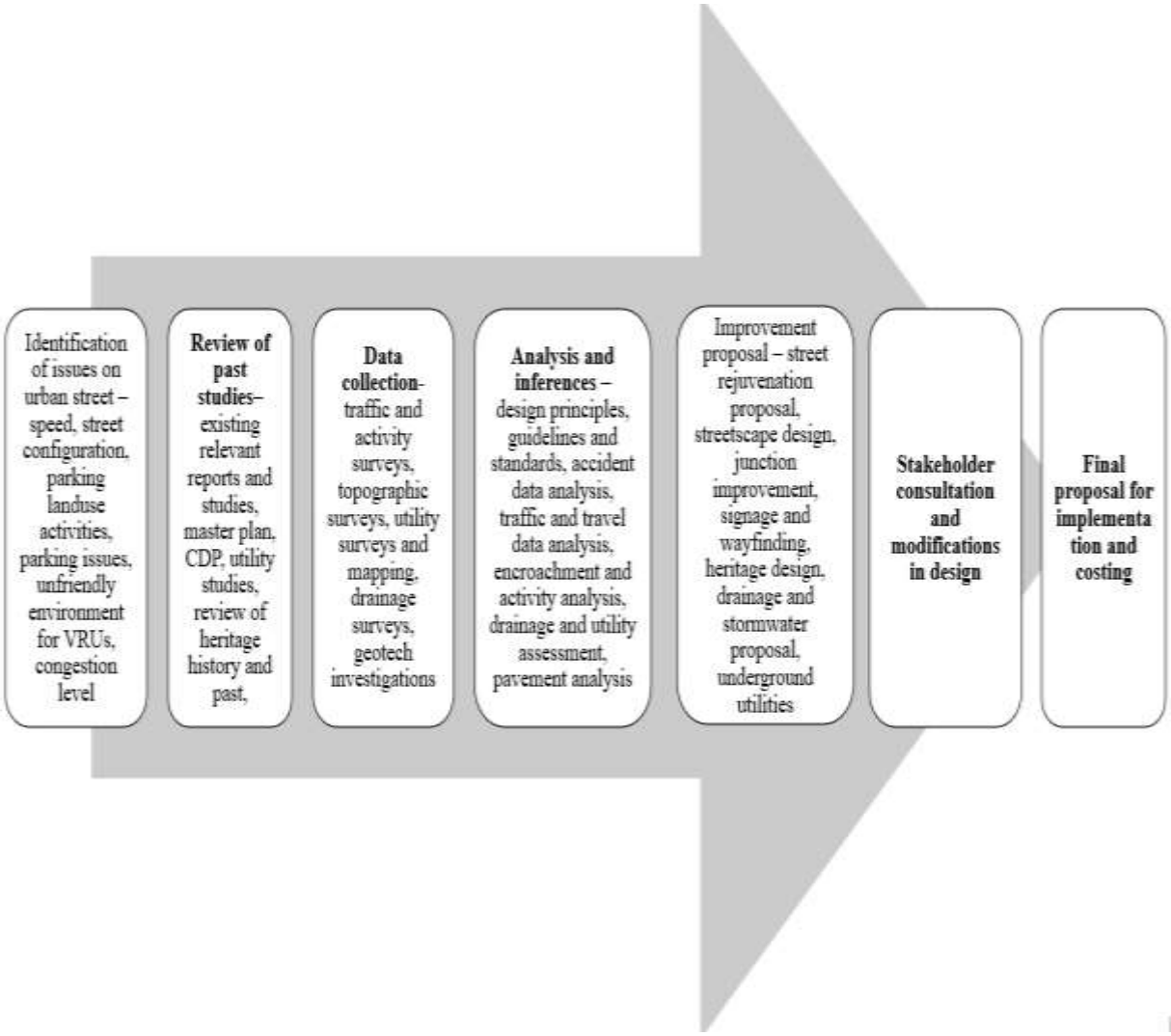


Source: Author

This concept is increasingly being adopted to transform street spaces to meet the needs of all users. It aligns closely with the principles of multidimensional street design. Numerous street revitalization and road diet projects are being undertaken both in India and globally to retrofit streets for various functions, guided by sustainable development goals (SDGs). The methodology followed for these projects include key steps which include traffic transportation surveys to understand travel pattern and volumes of various road users', primary and secondary data collection and analysis, development of solutions based on survey data findings, preparations of draft proposals, finalization of proposals through stakeholder consultations and finalization of plans as illustrated in figure 9. A conceptual illustrative example from India is shown

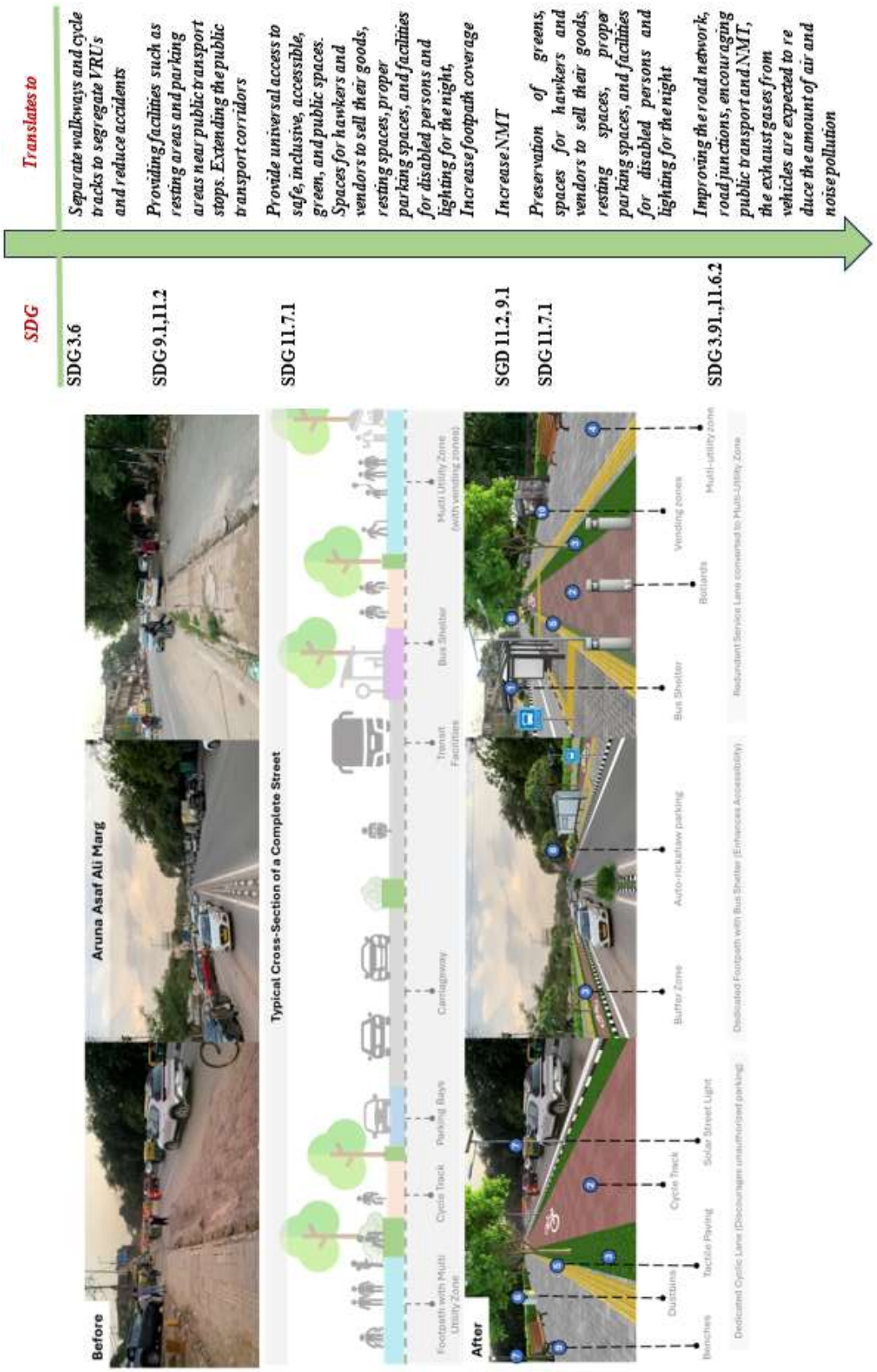
in figure 10, illustrating how different SDGs can be localized and applied to urban streets, addressing their diverse roles and functions.

Figure 9 Street Rejuvenation Project Methodology



The transformation of Aruna Asaf Ali Marg into a complete street exemplifies approach to urban street design by clearly designating space for various functions. Pedestrian movement is prioritized through the provision of wide, continuous footpaths integrated with tactile paving and multi-utility zones, enhancing accessibility for all users, including persons with disabilities. Auto-rickshaw parking has been formalized with designated bays to prevent encroachment on pedestrian areas. Bus stands are strategically placed within the multi-utility zone, complete with shelters to enhance commuter comfort. Additionally, space has been allocated for vending activities in a manner that maintains unobstructed pedestrian flow, with vending zones clearly demarcated. The addition of cycle tracks, buffer zones, greenery, and street furniture as benches further contributes to a safe, inclusive, and well organized realm that supports non-motorised transport (NMT) and aligns with SDGs related to accessibility, safety and environment quality.

Figure 10 Localisation of SDG on Urban Street Design



Source: Author

4. Conclusions

The evolution of urban street design reflects a significant shift from historical paradigms to contemporary approaches that address the diverse needs of modern cities. Initially focused on accommodating slow-moving, hand-drawn vehicles, street design has adapted to the demands of motorized traffic, often prioritizing vehicle flow at the expense of pedestrian and cyclist needs. The rise of New Urbanism has introduced a more integrated approach, emphasizing higher densities, mixed land uses, public transit, and an interconnected street network.

Today, the urban street design aims to balance transportation efficiency with safety and accessibility for various modes of travel including vulnerable users. Traditional hierarchical classifications have often led to segregated pedestrian and vehicular spaces. In contrast, contemporary approaches advocate for multi-dimensional design, integrating movement, activity, and mode priority.

The Complete Streets concept embodies these principles by focusing on effective space management, speed regulation, and mode priority. It aims to create streets that accommodate various transportation modes safely and efficiently, aligning with the SDGs to foster sustainable, resilient urban environments. By incorporating these multi-dimensional guidelines, urban streets can better serve diverse user needs ensuring safety and inclusivity and enhancing the overall quality of life in cities.

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